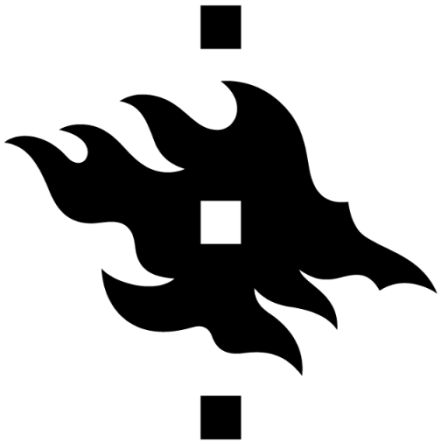

University of Helsinki
Department of Forest Sciences

Forest-based circular bioeconomy business models in Finnish SMEs

Master's thesis
Simo Veijonaho
May 2018

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Tiivistelmä – Referat – Abstract

Growing exploitation of natural capital has raised a concern towards Earth's capability to provide equal benefits for all in the future. The UN's Sustainable Development Goals addressed this issue and set the framework for private and public operators to implement and develop more sustainable solutions. Circular economy and bioeconomy have been presented as models to foster the economy along with sustainability transitions. However, the models have been criticized for taking overall sustainability for granted. As a result, the merged concept, circular bioeconomy, has been introduced to address such sustainability gap. The circular bioeconomy concept implies a more efficient resource management of bio-based renewable resources by combining the concept of circular economy and bioeconomy in strategic management level. These new concept demands both new technological innovations and new business model innovation.

This study explores similar and dissimilar patterns in the way Finnish SME propose, create and deliver value through circular bioeconomy business models. The study examines the relation of new concept to sustainability as well. The study was based on qualitative research, and semi-structured interviews were conducted with eight company managers or owners. The data were categorized into business model components and sustainable business model archetypes.

The results revealed that sustainability-oriented business model archetypes vary across the examined companies. Dominant ideas are substituting fossil-based materials and energy with bio-based one, and practices enabled by new technology such as production eco-efficiency. More radical principles were missing, for instance prolonging the material cycle before incineration or solutions to reduce consumer consumption. While environmental value was well covered in the business models of companies, contribution to social value was taken for granted as a narrow outcome of economic and environmental values.

As this study concerned the micro level perspective, for further studies would be beneficial to examine the meso and macro level transformation to get a more holistic view on business environment, where companies with circular bio-product innovations operate to reveal implementation barriers for the circular bioeconomy.

Avainsanat – Nyckelord – Keywords

circular bioeconomy, circular economy, bioeconomy, business models, sustainability, sustainable development

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Metsäpohjaiset kiertobiotalouden liiketoimintamallit suomalaisissa PK-yrityksissä

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Tiivistelmä – Referat – Abstract

Luonnon pääoman lisääntyvä hyödyntäminen on herättänyt huollen maapallon kyvystä tarjota yhtäläiset edut kaikille tulevaisuudessa. Ongelmien ratkaisemiseksi luodut YK:n Kestävän kehityksen tavoitteet asettivat puitteet yksityisille sekä julkisille toimijoille kestävämpien ratkaisujen toteuttamiseksi ja kehittämiseksi. Kiertotaloutta ja biotaloutta on esitetty malleiksi kestävän kehityksen edistämiseksi talouden rinnalla. Malleja on kuitenkin arvosteltu kokonaisvaltaisen kestävyyden pitämisestä itsestään selvyytenä. Tästä seurauksena syntynyttä käsiteiden yhdistelmää, kiertobiotaloutta, on ehdotettu kestävyysvajeen korjaamiseksi. Kiertobiotalous merkitsee biopohjaisten uusiutuvien luonnonvarojen tehokkaampaa hallintaa kiertotalouden mekanismien avulla. Nämä uudet käsitteet tarvitsevat sekä uusia teknologisia innovaatioita että uusia liiketoimintamalleja.

Tässä työssä tutkitaan suomalaisten Pk-yritysten kiertobiotalouden liiketoimintamallien samankaltaisuuksia sekä erilaisuuksia. Tutkimus tarkastelee myös uuden konseptin suhdetta kokonaisvaltaiseen kestävään kehitykseen liiketoimintamallinen kautta. Tutkimus toteutettiin laadullisena tutkimuksena puolistrukturoiduilla haastatteluilla kahdeksan yrityksen johtajan tai omistajan kanssa. Haastattelumateriaali kategorisoitiin liiketoimintamallin komponenttien ja kestävän liiketoimintamalli arkkityyppien mukaan.

Tulokset paljastivat, että kestävän kehityksen mukaiset liiketoimintamalli arkkityypit vaihtelevat tarkasteltujen yritysten välillä. Hallitsevina tyyppeinä ovat fossiilisten materiaalien ja energian korvaaminen biopohjaisilla vaihtoehdoilla, sekä uuden teknologian mahdollistama tuotannon eko-tehokkuus. Radikaalimmat käytännöt, kuten materiaalien kierron pidentäminen ennen polttoa tai ratkaisut käyttäjien kulutuksen vähentämiseksi, puuttuivat lähes kokonaan. Ympäristön arvo oli hyvin tunnistettu yritysten liiketoiminnoissa, kun taas sosiaalista arvoa pidettiin taloudellisen ja ympäristön arvon itsestään selvänä tuloksena.

Tämän tutkimuksen käsitellessä mikrotason näkökulmaa olisi tuleville tutkimuksille tärkeää tarkastella meso- ja makrotason muutosta kokonaisvaltaisemman näkemyksen saamiseksi kiertobiotalouden liiketoimintaympäristöstä tunnistaakseen toimeenpanoesteitä kiertobiotalouden suhteen.

Avainsanat – Nyckelord – Keywords

kiertobiotalous, kiertotalous, biotalous, liiketoimintamallit, kestävyys, kestävä kehitys

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Contents

1. Introduction

1.1 Background

Year after year, since 1971, the global consumption of natural resources has exceeded Earth's ecological footprint and biological capacity, the ability to regenerate natural resources and treat the atmospheric greenhouse gas emissions (Schaefer et al., 2006; Past Earth Overshoot Days, 2017). In 2017, the global overconsumption day was dated at the beginning of August (Past Earth Overshoot Days, 2017). However, in Finland the date passed considerably earlier, on the third of April (Country Overshoot Days, 2017). In that same year, the global demand for virgin raw materials has been 1.7 times higher than Earth's biological capacity (Past Earth Overshoot Days, 2017).

Material extraction has more than doubled globally during the past three decades (figure 1). The consumption of renewable materials has steadily grown during this period, and the greatest growth was due to the increased use of non-renewable resources, especially industrial and construction minerals (figure 1).

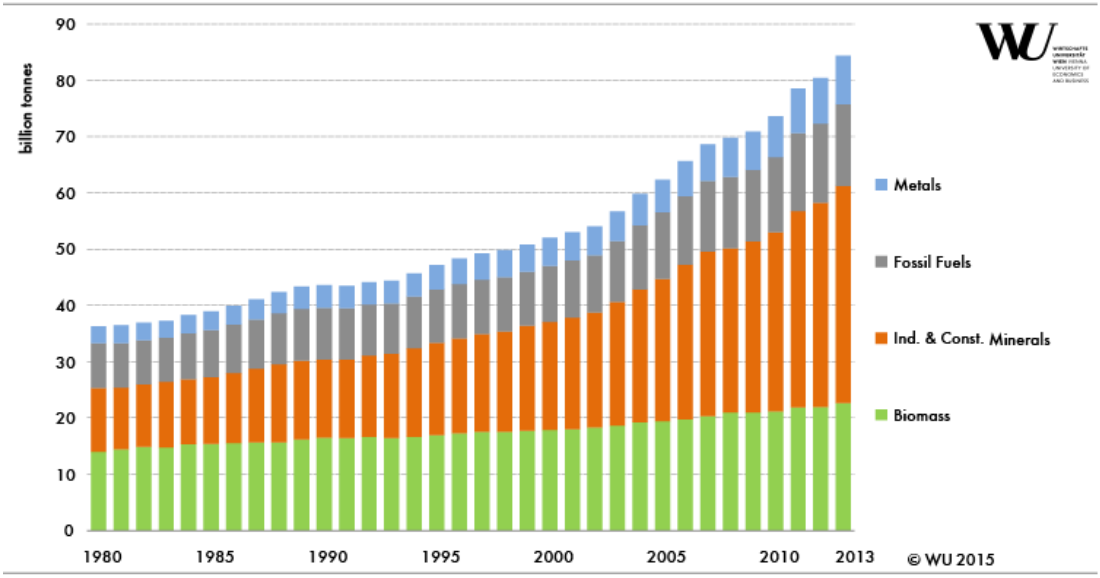

Figure 1. Global material extraction 1980-2013 (used materials), including metal ores, fossil fuels, industrial and construction minerals and biomass (from agriculture, forestry and fishery) (Global material extraction…, 2016).

Continuous unsustainable material extraction has already caused exceeding of planetary boundaries, a concept introduced by Rockström et al. (2009). The boundaries define the safe limits for human actions within the natural processes at the global level

(Rockström et al., 2009), after which irreversible ecological disruption would occur. Steffen et al. (2015) provided an update of the status of such boundaries, raising a concern in regard to high risks from biodiversity loss and biochemical flows as well as on increasing risk from climate change and land use change.

The present overuse of Earth's natural resources, synchronized with the predicted growth of population (UN, 2017), demands fundamental changes in our consumption and production habits of goods (Millennium Ecosystem Assessment, 2005; Wijkman and Skånberg, 2015; UN, 2015a). We could otherwise encounter severe economic, social and ecological challenges that can lead to rising raw material prices, extinction of species, collapse of whole ecosystems and increment of social inequality (Millennium Ecosystem Assessment, 2005; Rockström et al. 2009; UN, 2015a).

Intergenerational equality and justice in the availability of economic, environmental and social benefits, are commonly recognized as the core of the sustainability definition (WCED, 1987; UN, 2015a). In this context, a socio-ecological system perspective strives to illustrate the relationship between humanity and environment (Folke et al., 2016). This perspective stresses the importance of the Earth's biosphere (i.e. natural capital and ecosystem services[1]), as the ground of human existence. The human impacts (economic, political, technological and cultural) shape and alter the whole Earth system affecting other living habitants in diverse ecosystems (Folke et al., 2016).

United Nations' Sustainable Development Goals were set in 2015 to avert economic imbalance, ecological over-exploitation and social inequality (UN, 2015a). In the same year the Paris climate agreement of United Nations was negotiated to recognize, mitigate, adapt and finance actions against the climate change (UN, 2015b). These declarations did not offer direct solutions for sustainability challenges but were a global call for actions for the public and private sectors.

In Finland, one of the government's actions to meet the UN's agreements is guiding material consumption towards more sustainable economies: the bioeconomy and the

[1] Natural capital is the World's stock of natural assets (biotic and abiotic elements) which provides a wide range of benefits (namely, ecosystem services) to local and global people (e.g. food and fibers, climate and water cycles regulation, recreation and cultural values) (Braat and de Groot, 2012).

circular economy (The Finnish bioeconomy strategy, 2014; Leading the Cycle, 2016). These national strategies originate from the European Union's action programs and strategies, which underline resource efficiency as a necessary operation to meet the sustainable development goals (EC, 2012; EU: Decision 1386, 2013; EC, 2015).

The concern for the strain on ecosystem services, creating a potential risk for businesses, has not escaped private sector's attention (Whiteman et al., 2013; Winn and Pogutz, 2013; D'Amato et al., 2016). Given its dependence on natural capital and influence on society, private sector has an important role in implementing new economic models to achieve global sustainability goals (The Finnish bioeconomy strategy, 2014; UN, 2015a; Leading the Cycle, 2016).

The bioeconomy and the circular economy concepts are presented as avenues to shift the current economy towards a more sustainable one, even though their concrete contribution to sustainability challenges are in many cases still unassessed or debated (D'Amato et al., 2017; Geissdoerfer et al., 2017; Hetemäki et al., 2017). In particular, several scholars have suggested that in its aim to substitute non-renewables with bio-based materials and energy, the bioeconomy should also adopt guiding principles from the circular economy, such as product design in regard to material and energy efficiency, endurance and recyclability. This new emerging concept is called circular bioeconomy (Allen, 2016; Bezama, 2016; Antikainen et al., 2017), which "is more than bioeconomy or circular economy alone" (Hetemäki et al. 2017 p. 14). Hetemäki et al. (2017) argued that the concept of the circular bioeconomy is needed for meeting the Sustainable Development Goals and the goals of the Paris climate agreement. This novel concept demands innovations not only in products and production technologies but in business models as well.

New business model innovations are regarded as enablers for new concepts, such as the circular economy, the bioeconomy and the circular bioeconomy (Antikainen et al. 2017; Kirchherr et al., 2017; Hetemäki et al., 2017). To achieve the Sustainable Development Goals, systematic change in dominant global economic model must be applied (Hetemäki et al., 2017). Demand for radical innovations and changes is highly recognized both among researchers and NGOs (e.g. El-Chichakli et al., 2016; Lieder and Rashid, 2016; Hetemäki et al., 2017)

While some literature is emerging on circular economy or bioeconomy business models (e.g. Hansen, 2016; Manninen et al., 2018), circular bioeconomy business models are currently still under-investigated in business and sustainability -related literature. This thesis thus offers important insights on the business and sustainability potential of this concept.

1.2 Aim of the study

The objective of this thesis is to examine a set of Finnish small and middle-sized enterprises (SMEs) operating with circular bioeconomy business models, and their contribution to sustainability. The scope of this thesis particularly focuses on the forest-based products and services. The purpose of the results is to identify current archetypes of business model within new sustainable economy model, circular bioeconomy, and support companies' strategical decision making in contribution to achieve more sustainable and efficient businesses. The results also provide valuable insights on the development of forest sector in Finland.

The research questions aim at inquiring about internal and external influences of the companies' sustainability strategy. The first question examines the company's internal business model, while the second question regards the external influence on environment and society.

1. How do SMEs propose, create and deliver, and capture value through circular bioeconomy business models?
2. How does forest-based circular bioeconomy companies provide beneficial outcomes relative to social and environmental sustainability?

The structure of this thesis is as follows. In the literature review (section 2) the concepts of circular bioeconomy and business model are presented, along with the theories applied in this thesis. In section 3, the research method, the data collection and the data analysis are described and justified in light of reliability and validity, and limitations are articulated. Results and discussion are presented in sections 4 and 5. The appendix includes the questionnaire used for the data collection (English and Finnish versions) and the code list from the analysis.

2. Literature review

2.1 Circular bioeconomy

The concept of circular economy is currently experiencing a new momentum in sustainability science (Ghisellini et al., 2015; Geissdoerfer et al., 2017; Kirchherr et al., 2017), building on previous ideas of industrial systems and transformations, like the cradle-to-cradle, the performance economy, the product-service system, the industrial ecology or the industrial metabolism (Brennan et al., 2015; Murray et al., 2016; D'Amato et al., 2017; Geissdoerfer et al., 2017). The common objective is decoupling economic growth from the use of natural capital (Liu et al. 2008; Ellen MacArthur Foundation, 2012; Ghisellini et al., 2015; Wijkman and Skånberg, 2015).

The basis for the circular economy concept is adopting a more efficient resource management and abandoning a linear "take-make-waste" in favor of a "closed-loop" economy (Ellen MacArthur Foundation, 2012; Brennan et al., 2015; Ghisellini et al., 2015; Wijkman and Skånberg, 2015; Murray et al., 2016; Van Buren et al., 2016; Geissdoerfer et al., 2017). In other words, the concept strives for more efficient material and energy consumption and reduced waste and emissions of production (Ellen MacArthur Foundation, 2012; Wijkman and Skånberg, 2015; Murray et al., 2016; Van Buren et al., 2016). In addition, the circular economy emphasizes both sustainable design of products and production processes (Ellen MacArthur Foundation, 2012; Brennan et al., 2015; Murray et al., 2016).

According to the Ellen MacArthur Foundation (2012), the circular economy includes material flows of biological and technical nutrients (figure 2). The closed system is designed in a way that the cascaded organic material would be harmlessly restored into the carbon cycle of terrestrial biosphere and the reused or recycled inorganic material would not be withdrew from the cycle (figure 2) (Ellen MacArthur Foundation, 2012; Murray et al. 2016).

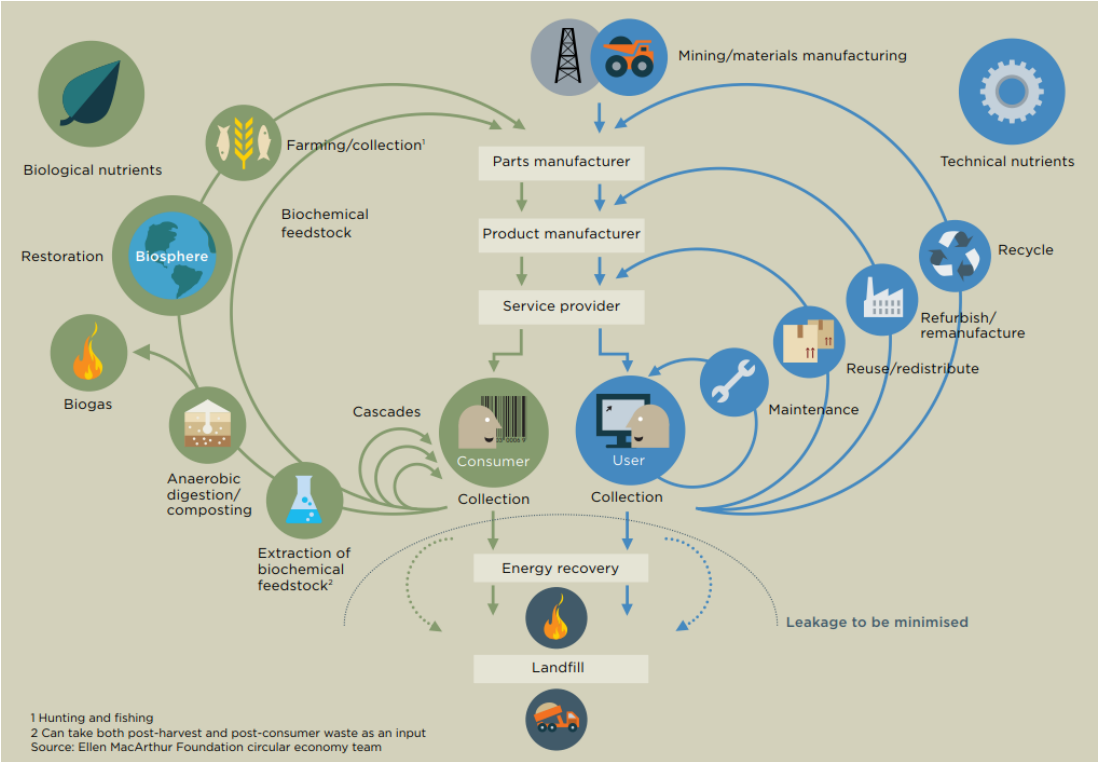

Figure 2. Outline of a circular economy (Ellen MacArthur Foundation, 2012 p. 24).

Various definitions of the circular economy have been proposed (D'Amato et al., 2017). In this thesis, we refer to the definition and conceptualization proposed by Kirchherr et al. (2017), according to which the aim of the circular economy is to support sustainable development. Core principles include the "4R" framework, the waste hierarchy and a systems perspective. The business models and consumers are considered as the enablers of the concept.

The "R" framework is about principles such as reducing (the use), reusing, recycling and recovering energy and material. Different "R" frameworks are identified as key tools to implement the circular economy into action (Liu et al., 2008; Brennan et al., 2015; EC, 2015; Ghisellini et al., 2016; Murray et al., 2016; Van Buren et al., 2016; Geissdoerfer et al., 2017; Kirchherr et al., 2017).

"Reducing" the use of resources implies diminishing the consumption of raw materials and the waste of production, and designing products with longer lifespan (Kirchherr et al., 2017). A challenge of the reduction principle is the inconsistency between enhancing durability and lightening the weight of the product at the same time (Brennan et al., 2015). It demands production efficiency improvements and technological innovations (Ghisellini et al., 2016).

"Reuse" relates to closing the loops, using products for the same purpose again or using parts of products as components in new products (Van Buren et al., 2016; Kirchherr et al. 2017). Repair, refurbishment and remanufacture are firmly associated with the reuse principle (Brennan et al., 2015; Kirchherr et al., 2017). With regular maintaining and cleaning, they enable longer lifecycle of unaltered products. (Brennan et al., 2015).

"Recycle" refers to utilizing waste as raw material either directly or after necessary processes (Van Buren et al., 2016; Kirchherr et al. 2017). Brennan et al. (2015) noted that recycling can be done upward or downward. Upcycling increases the value of material whereas down cycling reduces it (Brennan et al., 2015). Recycling is not an endless cycle, the value of waste as raw material gradually decreases, and finally it ends up in energy recovery or in landfills (figure 3) (Ellen MacArthur Foundation, 2012; Ghisellini et al., 2016).

"Recover" refers to transforming waste materials or residual flows into energy e.g. by incineration, gasification or pyrolysis (Brennan et al., 2015; Van Buren et al., 2016; Kirchherr et al., 2017). The recover principle is not highlighted as much as others in the "R" framework.

The waste hierarchy principle is about prioritizing the most desirable action to reduce and manage waste (i.e. preventing and minimizing first, followed by reusing and recycling, followed by recovering and disposing) (Brennan et al., 2015; EC, 2015; Kirchherr et al., 2017). The waste hierarchy is a legislative framework of the European Union's Waste Framework Directive 2008/98/EC, which guides European Union's waste management to "deliver best overall environmental outcome" (EU, 2008; Brennan et al. 2015; Ghisellini et al. 2016).

Many scholars accentuate that the circular economy concept promotes the implementation of sustainable development into businesses (Circular Economy Promotion…, 2008; EC, 2015; Wijkman and Skånberg, 2015; Ghisellini et al., 2016; Murray et al. 2016; Kirchherr et al., 2017). Kirchherr et al. (2017 p. 221) stated that: "the circular economy is viewed as an operationalization for businesses to implement the much-debated concept of sustainable development." Nonetheless, they point out that barely

a tenth of the examined definitions of the circular economy included the idea of sustainable development or all of its dimensions. Geissdoerfer et al. (2017) noticed the same paucity in their analysis.

A few existing case studies demonstrate potential economic growth achieved within the circular economy based industry (e.g. Ellen MacArthur Foundation, 2012; Wijkman and Skånberg, 2015). The case study of Wijkman and Skånberg (2015) projected a slight rise in GDP through the renewable, the energy and the material efficiency scenarios in Sweden, Finland, the Netherlands, France and Spain. The study of Ellen MacArthur Foundation (2012) discovered significant net material cost saving potential at the EU level. In addition, they recognized several probable benefits for the economy, like reductions in price volatility and supply risks (Ellen MacArthur Foundation, 2012). Major effects to the environment found in the case study of Wijkman and Skånberg (2015) were significant reductions of carbon emissions.

Various challenges have arisen in the circular economy concerning the economic and environmental aspects. Possible rebound effects of the circular economy and oversimplified goals are a concern, especially when meeting the energy demand of production (Brennan et al., 2015; Ghisellini et al., 2015; Wijkman and Skånberg, 2015). Murray et al. (2016) argued in their article that the circular economy should also integrate the idea of natural capital. Geissdoerfer et al. (2017) remarked that the land use and biodiversity issues are poorly discussed.

The social equity is often overlooked in the circular economy, compared to environmental quality and economic prosperity (Ghisellini et al., 2015; Murray et al., 2016; Geissdoerfer et al., 2017; Kirchherr et al., 2017). Murray et al. (2016) stated that, it is unclear how circular economy directly benefits social equity. Practically, the creation of new jobs is the only direct social benefit found in the case studies of Ellen MacArthur Foundation (2012) and Wijkman and Skånberg (2015). Kirchherr et al. (2017) detected that virtually every examined definition left mentioning the effect on future generations, even though intergenerational equity is also a fundamental part of the sustainable development approach (WCED, 1987). Finally, the transition into the circular economy will most likely require vast investments (Brennan et al., 2015; Wijkman and Skånberg, 2015). Wijkman and Skånberg (2015) calculated that 3% of GDP per annum until 2030 would be the required level of investments for the desired transition.

Ghisellini et al. (2016), Murray et al. (2016) and Kirchherr et al. (2017) stated that the circular economy takes places in three levels: single company or consumer level (micro); industrial level (meso); city, municipality or society level (macro).

The micro level operations are practiced by a company or a consumer (Ghisellini et al., 2016; Murray et al., 2016; Kirchherr et al., 2017). In a single company sector, the circular economy effects on production and product design (Ghisellini et al., 2016; Murray et al., 2016). Ghisellini et al. (2016) and Murray et al. (2016) highlighted eco-design and cleaner production as possible improvement strategies. In the case of a single consumer, the circular economy emphasizes the responsibility of consumers (Ghisellini et al., 2016). Practical examples, brought up by Ghisellini et al. (2016), are different labeling systems to facilitate more sustainable product purchases. In Finland waste legislation and recycling system enable consumers to be a part of the recycling system by sorting household wastes.

The meso level implementation requires broader industrial perspective (Ghisellini et al., 2016; Murray et al., 2016; Kirchherr et al., 2017). Often described practical example of the meso level operations are eco-industrial parks or industrial symbiosis, where the costs of resources and the consumption of virgin materials can be reduced by utilizing the residuals or wastes of others and by operating in synergies (Ghisellini et al., 2016).

The macro level transition towards the circular economy takes place at the city, the national and the global level (Ghisellini et al., 2016; Murray et al., 2016; Kirchherr et al., 2017). This macro level shift demands fundamental changes in consumption behavior, in infrastructures and in waste management systems (Ghisellini et al., 2016).

Kirchherr et al. (2017) considered new business models and the customers as enablers of the circular economy transition. This reflects the idea of Walter R. Stahel that companies should provide services instead of ownerships and customers should be users instead of consumers (Ghisellini et al., 2016; Geissdoerfer et al., 2017).

In their literature review, Kirchherr et al. (2017) discovered that the discussion around business models in the circular economy increased after the publication of the report of Ellen MacArthur Foundation (2012). This report clearly highlighted new business models as a practical tool for implementing the circular economy into industries. Brennan et al. (2015) and many other recent papers (e.g. Ghisellini et al., 2016; Lieder and

Rashid, 2016; Van Buren et al., 2016; Manninen et al., 2018) emphasized likewise the need for new business models in the adaptation to the circular economy.

While development of business models concentrates on design of product and production system from the business perspective, customers, as end-users and payers, have more responsible role in the implementation of the circular economy (EC, 2015; Lieder and Rashid, 2016; Van Buren et al., 2016; Kirchherr et al., 2017). The consumers are enablers for the circular economy, even though their role is often overlooked (Kirchherr et al. 2017). Ghisellini et al. (2016) highlighted the consumer responsibility and awareness: responsible customer not only recycles or returns products but also optimizes the balance between consuming goods and using services (Ghisellini et al., 2016).

The use of renewable bio-based resources rather than fossil ones to produce food, energy and commodities is the ground of the bioeconomy concept (EC, 2012; The Finnish Bioeconomy Strategy, 2014; Pfau at al., 2014; Priefer et al., 2017). The aim is to shift the resources utilization towards biological materials with shorter carbon cycle. However, the focus of the bioeconomy concept varies between definitions (Bugge et al., 2016; Meyer, 2017). While some definitions highlight more the biotechnological and the bio-resource side of the bioeconomy, others see it as comprehensively ensuring more sustainable and environmental friendly production of food, energy, products and services (Bugge et al., 2016; Meyer, 2017). In this thesis, the bioeconomy refers to innovations in terms of new products and services based on forest biomass-based resources.

According to the literature review carried out by Pfau et al. (2014), the most apparent driver for development of the bioeconomy is the need for reducing dependence on non-renewable fossil resources. The purpose for reduction is to avoid future risks such as geopolitical and environmental uncertainty of the remaining fossil fuel reserves and consequent unpredictability of prices (Pfau et al., 2014; Priefer et al., 2017).

The second most relevant driver is a concern for environmental sustainability. In particular, the bioeconomy aims at substituting the fossil fuels to mitigate the greenhouse gas emissions and carbon footprints (Pfau et al., 2014; Priefer et al., 2017).

Since for the most part bio-based resources originates from forestry and agriculture biomasses, the development of rural economy is assumed to benefit from the bioeconomy (Pfau et al., 2014). This benefit is obtained from the decentralization of supply chains, and from new jobs creation (Pfau et al., 2014; Priefer et al., 2017).

The contribution of the bioeconomy to sustainability has been claimed variously in definitions and visions of the bioeconomy (Pfau et al. 2014; Bugge et al., 2016). Economic prosperity is prioritized, while environmental well-being is assumed and social aspect loosely treated (Pfau et al. 2014; Bugge et al., 2016; Priefer et al., 2017). Pfau et al. (2014), however, examined controversies on the relationship of the bioeconomy and sustainability, finding out, that: "the bioeconomy cannot be considered as self-evidently sustainable". The biggest identified pitfalls in the bioeconomy relate to land use issues, ambiguous reduction of greenhouse gas emissions, and to negative effects caused by biomass production in natural systems (Pfau et al., 2014; Meyer, 2017; Priefer et al., 2017).

Recent discussion on the sustainability potential of both the circular and bioeconomy (e.g. Geissdoerfer et al. 2017; Priefer et al., 2017) prompted the need for a third concept, the circular bioeconomy, which promises more sustainable outcomes than the individual concepts alone (Allen, 2016; Antikainen et al., 2017; Hetemäki et al., 2017). The circular bioeconomy model could represent a solution for sustainability matters, such as land use issues because European forest-based resources do not compete for land with food production (Antikainen et al., 2017; Hetemäki et al., 2017). On the contrary, novel products and technics of production, for instance textiles from wood fibers, would reduce the water consumption and pesticides as well as the land needed for cotton cultivation, releasing it to food production (Antikainen et al., 2017).

The foundation of the circular bioeconomy is the bioeconomy availing the core principles of circular economy, providing bio-based products and services with longer lifespan, higher endurance and free of toxicity (figure 3) (Allen, 2016; Antikainen et al., 2017; Hetemäki et al., 2017). The lifecycle of bio-based products would be designed in the terms of the circular economy (Allen, 2016; Bezama, 2016) to address the current sustainability shortcomings (Hetemäki et al., 2017). Hetemäki et al. (2017) emphasized the importance of including ecosystem services and natural capital into

discussion of the circular bioeconomy: "you cannot have bioeconomy without biodiversity" (Hetemäki et al., 2017 p. 8).

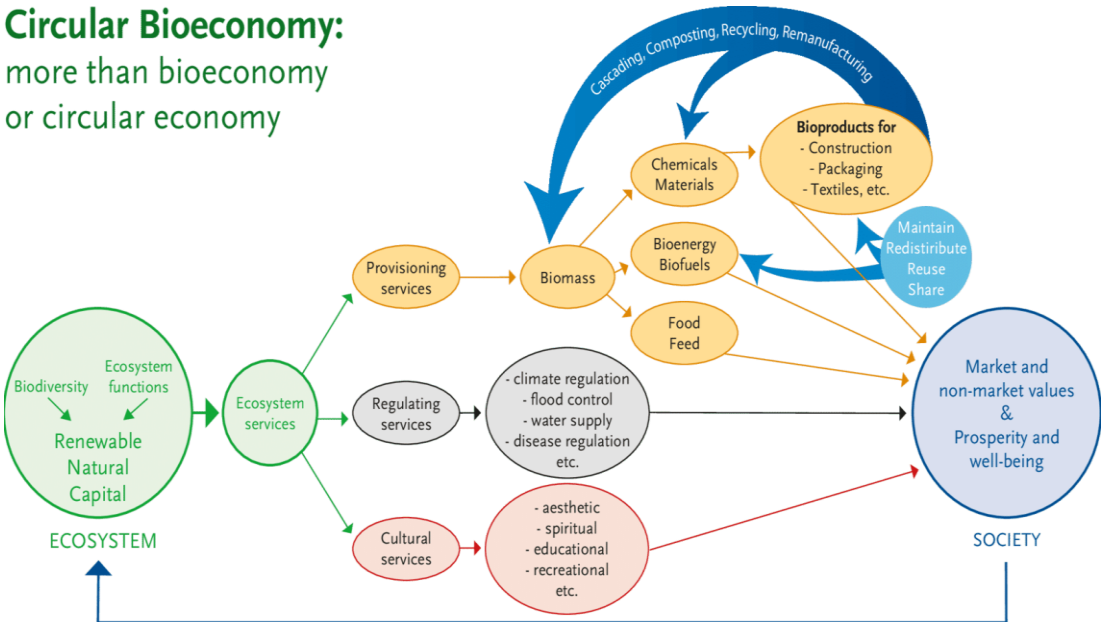

Figure 3. The relationship between circular bioeconomy and ecosystem services as illustrated by Hetemäki et al. (2017).

Given the emerging nature of the concept, there is still poor recognition in scientific literature and policy making, compared to grey literature (Antikainen et al., 2017; Hetemäki et al., 2017). Hetemäki et al. (2017) state that European Union's circular economy package fails to connect the circular economy to the bioeconomy although bio-based materials are recognized as a crucial part. Antikainen et al. (2017) highlighted two practical challenges for implementation: the lack of circular economy design in bio-based products in the first place, and the lack of recycling and recovery of products. Bezama (2016) saw this to be derived from the lack of dialogue between product designers and waste industry. Bezama (2016) also remarked that the current lifecycle assessment system would not be sufficient to analyze vertically and horizontally multilayered industrial networks brought by circularity.

2.2 Business model concept

The business model is a relatively young concept in business literature. Scholars such as Osterwalder et al. (2005), Richardson (2008) and DaSilva and Trkman (2014) have recognized that it achieved remarkable popularity in both academic and practical pub-

lications at the end of the 1990s when the internet and technology business was booming. Yet, the definition of the business model has been lacking shared theoretical understanding in scientific literature (Osterwalder et al., 2005; Richardson, 2008; Teece, 2010; DaSilva and Trkman, 2014; Wirtz et al., 2016). A large number of studies have proposed different descriptions and characterizations of the business model as a concept (Wirtz et al., 2016). It can be recognized that creating value for stakeholders, arranging the resources and the business network, and implementing properly designed transaction system are connected with the components of the business model.

Despite the disagreement on the definitions or the components of the business model, many studies agree, that the concept of business model is not to be confused with other concepts e.g. business strategy, business process model or economic and revenue model (Osterwalder et al. 2005; Richardson 2008; DaSilva and Trkman, 2014).

Osterwalder et al. (2005) explored the foundations of the business model concept. They did not primarily seek the answer for what the business model is, but they considered the business model as a translator of a company's strategy into a conceptual model: "…that explicitly states how the business functions." (Osterwalder et al., 2005 p.2). This view has been applied in later studies (e.g. Teece 2010, DaSilva and Trkman 2014, Wirtz et al. 2016). Richardson (2008) and DaSilva and Trkman (2014) argued both that the business model is more like a mechanism which enables a company to implement its strategy into practice to create value for customers and to get the competitive advantage over rivals.

While the business model is seen as the company value creating mechanism, the business process model is rather how a single business case is executed in operations (Osterwalder et al., 2005). The business process model (or modeling) is a further detailed description of activities, which illustrate the business operations of companies (DaSilva and Trkman, 2014).

DaSilva and Trkman (2014) stated that the economic model has been understood as a synonym for the business model in the past, but nowadays it can be seen as a more destitute model for operations of companies. The revenue model alone is just a part of the business model (Richardson, 2008; DaSilva and Trkman, 2014).

Based on a literature review, Richardson (2008) built an integrative framework for the business model, consisting of the value proposition, the value creation and delivery

system, and the value capture. In this framework, the value proposition is regarded as the company's answer to the needs of target customers, or as the competitive advantage of a company. The value creation and delivery system arrays company's resources and relationship network to acquire the competitive advantage and to create the value for its customer. The value capture defines the streams of revenues and profits (Richardson, 2008).

By recognizing and analyzing the examples of the business models within the traditional and technology industries, Teece (2010) constructed his view of the business model, including components of the value creation, the value delivery and the value capture. Through hardly imitable elements, a company converts customers' needs to profit by utilizing suitable resources and in this way gains the competitive advantage. Teece (2010) stated that every company executes a business model whether knowingly or unknowingly.

In their theoretical analysis, DaSilva and Trkman (2014) clarified the description of business model by coupling the resource-based view with transaction cost economics. They defined the business model to represent the collection of a company's resources and the way of transactions are done together to create the value for stakeholders.

Increasing amount of innovations during the information technology boom forced companies to rethink their business and revenue models leading to the development of novel forms of the business models (Osterwalder et al., 2005; Teece, 2010; Boons and Lüdeke-Freund, 2013; DaSilva and Trkman, 2014; Wirtz et al., 2016), because companies had to maintain their competitive advantage. Technological development and innovations transformed the substance of the existing business models.

Teece (2010) argued that the business model is a critical tool when technological innovation is brought to the market, as many great technological innovations cannot create value to customers if they are not supported by proper business model. Yet, there are exceptions, especially among the innovations on manufacturing technologies, as those are aimed at reducing the production costs (Teece 2010).

While the end of 1990s generated many information technology innovations, later decades have seen growing concern towards excess use of non-renewable resources and a consequent increase of sustainable innovations (or eco-innovations). These sustainable innovations in technological, social and organizational levels shaped reciprocally the

substance of business models within the industry of sustainable business (or green business). By connecting the business model concept with sustainable-oriented innovations Boons and Lüdeke-Freund (2013), Boons et al. (2013) and Bocken et al. (2014) composed an overview on sustainable business models.

Inspired by previous studies (Osterwalder, 2004; Doganova and Eyquem-Renault, 2009), Boons and Lüdeke-Freund (2013) constructed a sustainable business model on four components: the value proposition, the supply chain, the customer interface and the financial model. According to Boons and Lüdeke-Freund (2013), from the viewpoint of sustainable innovations, the value proposition does not only provide economic value but also ecological and social values. A company embeds these values to its products and/or services (Boons and Lüdeke-Freund, 2013). They construed, that in the supply chain, a company strives to collaborate with sustainably responsible suppliers and sub-suppliers. At the customer interface level, a company acts as an instructor and drives customers towards more responsible and sustainable consumption (Boons and Lüdeke-Freund, 2013). Boons and Lüdeke-Freund (2013) remarked that in both the supply chain and the customer interface, the company does not devolve its own responsibility to its stakeholders. Furthermore, the financial model distributes income and expenditure fairly between parties (Boons and Lüdeke-Freund, 2013).

In light of sustainable innovations, business models and the economic performance, Boons et al. (2013) presented a compressed version of the business model concept, where the customer interface and the supply chain were combined into "the configuration of value creation" component. This model considerably resembles the one Richardson (2008) presented earlier, and was later realigned in the study of Bocken et al. (2014).

In their literature and practice review, Bocken et al. (2014) formulated eight different archetypes of the sustainable business models. The archetypes were categorized into three groups by innovative aspects: technological, social and organizational.

The technological group includes archetypes relating mostly to company's supply chain and research and development: maximize material and energy efficiency, create value from waste, and substitute with renewables and natural processes. The social group consists of archetypes aiming to greener immaterial values and attitudes: deliver functionality rather than ownership, adopt a stewardship role, encourage sufficiency.

The organizational group contains archetypes concerning the company's organizational structure: repurpose for society/environment, develop scale up solutions. Every archetype creates the value for its stakeholders through different business model. Concrete progress towards sustainability is achieved by using combinations of the archetypes (Bocken et al., 2014).

The framework of this thesis was pilled on the study of Bocken et al. (2014). The framework consisted of the business model components, including slightly modified sub-dimensions, and the sustainable business model archetypes. The framework is illustrated in the figure 4.

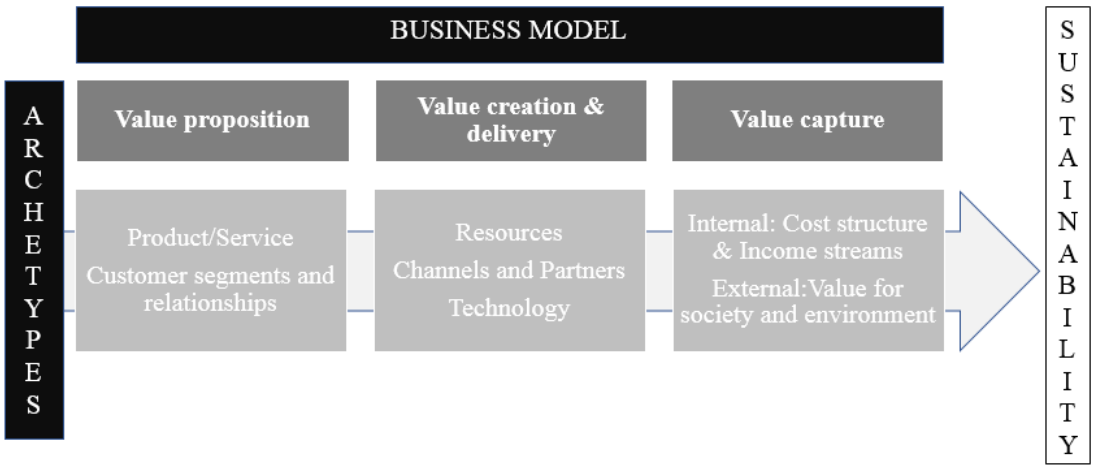

Figure 4. Framework of the study. Constructed on the basis of sustainable business model archetypes and business model structure adapted from Bocken et al. (2014).

3. Data and methods

3.1 Research method

Since the phenomenon at study is just emerging, explorative qualitative research methods are used to elicit knowledge and experience by individuals. Qualitative research methods are acknowledged as an effective tool in management and business administration research (Gummesson, 1991).

Qualitative data, e.g. the human experience, can reveal and explain nuances and complexities of phenomena more in-depth compared to quantitative data (Anderson, 2010). Qualitative research does not necessarily confine the researcher to a predetermined frame (DiCicco-Bloom and Crabtree, 2006; Anderson, 2010), but it enables to more freely lead and explore emerging topics during the data collection. (DiCicco-Bloom and Crabtree, 2006).

Possible technical limitations of qualitative research derive mainly from the influence of researcher's skills, personal bias and eccentricities (Anderson, 2010). For instance, in the data collection phase, the sample size of interviews can influence the validity of the study (Marshall et al., 2013), while the research setting and researcher's own personality can affect the responses (DiCicco-Bloom and Crabtree, 2006; Anderson, 2010). Mistranscription or misinterpretation of spoken word can affect the reliability of the data (DiCicco-Bloom and Crabtree, 2006). Other possible issues relate to compliance with ethical requirements. For instance, ethical limitations concern providing sufficient information on the nature of the study, guaranteeing the anonymity and confidentiality (DiCicco-Bloom and Crabtree, 2006; Anderson, 2010). However, the influence of many of these threats can be reduced beforehand (discussed in the section 3.4).

3.2 Data collection

The research data was collected by interviewing owners or managers of relevant companies. The interviews were carried out face-to-face at the companies' headquarters, or by phone, during February, March and April 2018.

Small- and middle-sized companies were selected by purposeful sampling from a website of a government-based platform promoting export of Finnish circular bioeconomy companies (Circular bioeconomy, 2018). Purposeful sampling is the most appropriate strategy to provide adequate sample for the study based on human experiences on a specific phenomenon (Maxwell, 2009). From the website, 13 companies were preliminarily selected among those dealing with products or services based on forest biomass resources, in relation to packaging, cosmetic, textiles, composite and pharmaceutical products.

Selected companies were approached by email and phone to explain the purpose of the study and inquire about willingness to participate. The participation invitation was addressed to the most relevant persons in the company's management group, possibly those responsible of company's strategy formation or corporate sustainability communication. The location and the time of the interviews were agreed individually.

Four companies refused to participate in the study and one company was not reached. In total eight representatives of these companies participated in the study (Table 1.). The individual interviewees and the companies were guaranteed anonymity. As the primary purpose of this study was to explore business models based upon circular bioeconomy concept, the names would have been irrelevant addition for the study.

Table 1. List of selected companies, the roles of representative and main products/services.

Company	**Role**	**Main business areas**
A	CEO	Transparent packaging material for food industry
B	CEO/Founder	Water-resistant composite material for household fixtures
C	CEO	Medical device/cosmetic product
D	CEO/Founder	Staple fiber for textile and non-woven industries
E	CTO	Biotech enzymes and services for customer
F	CEO	Ideas and patents for pharmaceutical products
G	CEO/Founder	Packaging material for packaging industry
H	Export manager/Owner	Composite material for kitchen utensils and dinnerware

Ultimately, eight interviews were conducted. Two of them took place at the headquarters of the companies (Helsinki region) and six were done on the phone. Interviews lasted on the average 27 minutes, varying from 20 minutes to 45 minutes, while in total they took approximately 215 minutes.

The interviews were carried out by applying semi-structured interview, where there is a predetermined outline of topics and questions to discuss (DiCicco-Bloom and Crabtree, 2006). This allows a more in-depth dialogue than solely structured interview (DiCicco-Bloom and Crabtree, 2006; Kvale and Brinkmann, 2009). This is important, as the purpose of this qualitative interview research is to examine interpretation of the perceptions, experiences and knowledge of the interviewees on emerging phenomenon (DiCicco-Bloom and Crabtree, 2006).

The interview questionnaire (Appendix 1) was sent to participants few days before the interview. The questionnaire, including open questions, was designed based on the theoretical framework of sustainable business model proposed by Bocken et al. (2014). The questions aimed at eliciting experience and knowledge of the interviewee on the phenomena at study. Questions 1-5 inquired about background information for the company and interviewee. Questions 6-8 were about the company business model value proposition. Questions 9 and 10 were created to answer the value creation and delivery component. Finally, questions 11-13 looked into the value capture. Since the interviews were conducted in Finnish, the questionnaire was made first in English and then translated to Finnish.

During the interviews, the audio was recorded and notes were taken of key points to support the recordings (Kvale and Brinkmann, 2009); shortly after the meeting, written summaries of the interviews were composed, and the audio was transcribed using the web-based software oTranscribe. Transcribed interviews were then back translated in English.

3.3 Data analysis

The data analysis was started almost simultaneously with the interviews. This helped develop and transform the interviews according to emerging data (Maxwell, 2009). The notes and summaries produced during and shortly after the interviews provided an opportunity to reflect on whether the questions were leading towards expected answers, and to assess data saturation.

Transcribed data were analyzed by coding the data into categories, using a computer assisted qualitative data analysis software, namely Atlas.ti version 7.5.18. Coding was

selected as an appropriate analysis strategy to concentrate on the meanings of interviews' contents (Kvale and Brinkmann, 2009), where "The goal (of coding) is to develop categories that capture the fullness of the experience and actions studied" (Kvale and Brinkmann, 2009 p. 202). The interview memos and summaries were used to support the formation of categories and to interpret the results.

Coding categories can be concept-driven, predetermined, categories, which are deductively formed before the data collection based on the theory (Kvale and Brinkmann, 2009); inductively arising data-driven categories, which are developed by comparing the similarities and differences of experiences and actions of interviewees (Kvale and Brinkmann, 2009); or abductively interplaying throughout the analysis between the observations and the theory to compose categorizes (Timmermans and Tavory, 2012). In this study, we started with predetermined concept-driven coding categories which were: business model components; archetypes of sustainable business models.

The same code was categorized simultaneously into one of the business model components (value proposition, value creation and delivery, or value capture) and into sustainable business model archetypes (figure 5). Allocation of archetypes was made examining the entirety of the business models of companies and compared how it matches with the definition of the literature based archetypes. Each business model component also included subcategories (see Appendix 2). Additional codes were also created outside the predetermined categories, to identify company motivation, growth strategy, and future business challenges and opportunities. The coding categories were constantly refined during the analysis by fitting them into data.

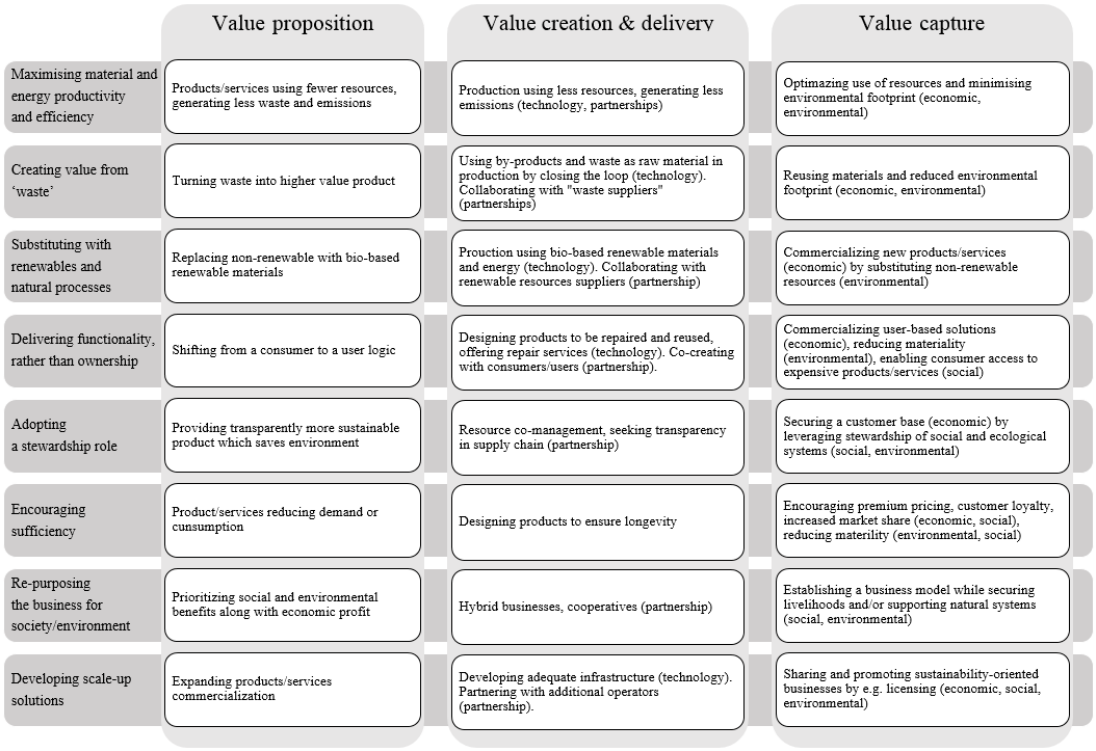

Figure 5. Coding framework adopted from Bocken et al. (2014)

3.4 Limitations

To ensure the validity and the reliability of the data, limitations are recognized and treated before, during and after the data collection and analysis (Kvale and Brinkmann, 2009). Although it is impossible in qualitative research to minimize all the threats, it is important to recognize them and their influence on the analysis and results (Maxwell, 2009; Kvale and Brinkmann, 2009).

Researcher's bias, personal values and preconceptions, can effect on the data collection and analysis (Maxwell, 2009). For instance, sample selection and questionnaire design can be a delicate phase in the process. For this study, the purposeful sampling of companies as well as the questionnaire creation was co-developed together with the supervisors of the thesis. The interview followed pre-structured questions, and additional questions were meant to be clarifying, not leading. The questionnaire was revised and pre-tested based on the comments by four English and Finnish speaking researchers.

Reactivity, meaning the interviewer's effect on the interviewee, is recognized as a possible validity threat before interviews. Due to characteristics of the interview, it is not possible nor desirable to fully lose the effect (Maxwell, 2009). However, such problem was minimized by creating an interview situation as relaxed and open as possible, the interviews were conducted in the location, the time and by the means most suitable to the respondents.

The amount of collected and analyzed data is considered sufficient, when it examines phenomenon comprehensively and its saturation is reached (Maxwell, 2009). In qualitative interview research the sample size varies greatly, so there cannot be a pre-determined number of interviews (Marshall et al., 2013). The sample size of this study was relatively small for qualitative interview research (Marshall et al., 2013). One limiting factor was the small number of existing companies associated with forest-based circular bioeconomy (excluding those working in energy sector). In total, the companies agreed to participate to the study were more than half of the potential sample. Saturation was reached after seven interviews, when the additional interview did not provide new insights on the phenomena at study (Marshall et al., 2013).

Participants were guaranteed full anonymity for themselves and their company. Nonetheless, they might not have provided in-depth answers about their business model if the disclosed information would reveal key competitive advantages and/or if such advance would be easily imitable. To determine the consistency of the answers, it would have been preferable to conduct comparative interviews with different people in the same company. However, most of the selected companies are startups consisting only of few representatives, thus limiting such possibility. Instead the answers were compared to other sources, such as the material disclosed by companies on their websites.

To ensure minimum information loss, accurate transcriptions of the audio recordings and translation from Finnish to English were produced by the same person conducting the interviews, who is proficient in both languages.

4. Results

4.1. Company motivation and background

The motivation to establish the companies, in most cases, was to commercialize technological innovation or other discoveries, with the exception of Company A. The establishment of Companies D and G was driven by the idea of commercializing technological innovation for manufacturing new materials. Company E's establishment was based on the technology as well, but it concerned biotechnological solutions. Companies C and F derived from the commercialization of pharmaceutical properties of forest products. Although the initial motivations for the establishment of Company H over ten years ago was concentrating on the die-casting business with different material, new raw material combination enabled the commercialization of new product family. The same motivation was behind the establishment of Company B, as the CEO expressed it: *"There is no other initial motivation behind, but to commercialize wood composite material innovation."* (CEO, Company B).

However, motivation of Company A diverged significantly from the others, as it was established based on the idea to replace plastic with a more sustainable material starting from the final end of the value chain: *"We have started maybe from the fact that visions, stories and mental images come first, and then we just develop the product to fulfill that."* (CEO, Company A). They knowingly differentiated themselves from the traditional view of companies established based on production technology. They first set the goal by composing the value proposition for customers for more environmental friendly solution, then they searched the technology and product to match that, like the CEO of Company A explained: *"But if we start from understanding and serving the customer's needs, and first think about the commercialization, then we can find the knowledge and develop the technology as well."*

4.2. Business model archetypes

The business models of the companies were categorized based on the sustainable business model archetypes defined by Bocken et al. (2014). Archetypes are presented starting from the most frequently recorded archetype.

"Substituting with renewables and natural processes"

The most commonly identified archetype among the companies was "Substituting with renewables and natural processes", which appeared in the business model of every company. The proposition for customers was primarily replacing non-renewable materials with bio-based renewable materials, as stated sententiously for instance by CEO of Company G: *"And from that we started to think that first business plan. In practice replacing plastic with new wood-based solutions."* Company E did not have a direct end-product, which would substitute other materials, but they were providing biotechnological solutions for others to create new bio-based value chains: *"But then when it comes to bio-refinery, renewable chemicals and other similar technologies, new materials, lean-based Nano cellulose and so on… They are uprising technologies, value chains, which still have gaps. And it requires enormous cooperation with different stakeholders, companies, universities. And we have quite successfully been able to act as a catalyst there, to create these value chains."* (CTO, Company E).

The propositions were created and delivered by different means. For instance, interviewees from Companies A, B, D and G emphasized that they had developed the new technologies in material production, making it possible to create new bio-based materials. As CEO of Company D stated: *"And then our innovation is that we have been able to solve the issue of producing very thin and good quality long-textile fiber from fine-grinded micro fibrillated cellulose with this kind of nozzle technology."* While the other companies with new production technologies underlined that the manufactured material can be reprocessed with existing production infrastructure into end-products, the company B had also developed unique production technology for their end-product: *"So, we produce them in the way we have now learned, and there has been quite a lot effort in developing our own production technology. We have our own mold technology."* (CEO, Company B). New technologies not only enabled the use of bio-based materials in new products but new bio-based raw material combinations made also possible to improve the qualities of materials. Interviewees from Companies B, G and H noted that their end-products have improved qualities compared the competitors. CEO of Company G explained: *"Well in practice the competitive advantage of our product, or this Company G's material, is based on the fact that we have been able to improve the performance of the product through this new production technology."* and furthermore stated: *"…adapting it to a new formula of materials we would get paper*

with plastic-like qualities." For Companies C and F, scientific finding on pharmaceutical properties of forest products enabled the use of uncommon forest-based raw materials for medical solutions: *"…this use of tree resin components is very unique. It is so that the raw material is surely very different."* (CEO, Company C). While mainly the proposition was delivered through material choices, in addition to manufacturing products with composite materials, Company H also used renewable energy in their production process.

It was found that incomes for these products came from new market areas, where there are not the similar products from forest-based materials. Improved and unique qualities of materials also create the competitive advantage for these new materials: *"As far as we know there are no competitors in bathroom fixtures made from composite materials."* (CEO, Company B). It was also noted that the costs of renewable raw materials will drop in the long term, when bigger volumes are processed: *"for bigger volumes the price of these good renewable bio-based raw materials we are using, drops."* (CEO, Company A).

Environmental benefits were distinctly communicated during the interviews. One benefit, also overlapping with the archetype "Maximizing material and energy efficiency", was the reduction of environmental stress, or environmental footprint, in the production phase, when new production technology enabled the use of forest-based materials replacing non-renewable materials. From the end-product perspective an explicit example of reduction was replacing the plastic packages with biodegradable materials reducing the plastics ending up in the environment. As mentioned by CEO of Company A: *"That if we think that the packaging industry is the biggest single plastic users and a third of packaging plastics ends in the nature and oceans and we have 165 million tons of waste in the ocean, plastic waste that floats there. We are involved in solving the problem because our material will transform into water and carbon dioxides in moderate time, when released in the nature. So, it is of course that kind of quite big thing concerning the environmental sustainability."*

"Maximizing material and energy productivity and efficiency"

Identified companies belonging to "Maximizing material and energy productivity and efficiency" archetype were B, D, E, G and H. The proposition of this archetype was to

offer environmentally less consumptive production compared to functional competitors by reducing the use of resources and causing less waste, emissions and pollution: *"At least 99% less water is used in this our technology. We do not use any hazardous chemicals and we are very energy efficient."* (CEO, Company D)

The proposition was mainly provided by production technology innovations enabling to use less inputs in production; generating less undesirable outputs; and developing safer and/or non-chemical processes. Several interviewees made comparisons to production technologies of competitive products and materials: *"But it has advantages compared to ceramics: it does not require such high temperatures, carbon dioxide is not released and the production process is safe, whereas ceramic industry is quite polluting. They consume enormous amounts of energy and clean water, and nitrogen oxides and Sulphur dioxides and actually just dust are released into the air."* (CEO, Company B). Company E diverged from the other companies as they were providing biotech-based production enhancing solutions for customers, aiming to reduce the environmental footprint of customer's production. On the other hand, for Company H qualities of new material combination has made it possible to reuse wastes minimizing the overall wastes from the production: *"Actually, compared to plastic, the qualities of natural fiber composite will improve, if it is reused, while on the other hand the quality of plastics will drop."* (Export manager, Company H)

The economic value from this archetype was given by a reduction in raw material costs: *"…functionally the same product, can be produced with half of the material. And this in practice doubles the unit price of our product."* (CEO, Company G).

The contribution to the environment was on reducing environmental stress in production, where less inputs are needed, and less emissions, waste and pollution are created. This was communicated by every company present in this archetype.

"Adopting a stewardship role"

Companies A, D, E, G and H was categorized into "Adopting a stewardship role" archetype according their overall business model and actions to provide sustainability throughout their supply chain. They stood out by their operations to create transparently sustainable brand. It was communicated during the interview and on their websites. They explicitly expressed, taking care of the whole value chain making sure that

in the end both the brand value and the sustainability value is preserved, and assured for the customers, like the CEO of Company D expressed: *"…we have brand owners as our partners, or we want to that way that we will go there to have a conversation with brand owners to ensure that the ecological, environmental friendliness of our raw material, our fiber, remains throughout the whole production chain. And that eventually the brand value is achieved."*

These companies shared a clear vision of more sustainable value chain and they are communicating that openly for the stakeholders on their websites: *"if you looked at our website, we try to openly tell the story about what we are doing and to what it is based on. And explicitly mention that how sustainable the whole production chain is, and how ethical it is and what kind of social influences it can have. That it is in the core of our thing."* (CEO, Company D)

In terms of raw material supply, to ensure the sustainability Companies A, D and H are using third party certified raw materials, which was communicated either on their website or during the interview: *"we are talking about virgin materials, even though from FSC certificated forest."* (CEO, Company A). Interviewees from Company G and H told that they are assessing their lifecycle impacts. In the case of Company E, this was found out from their website. CEO of Company G explicitly noted that it is not public information yet as it can be regarded as competitive advantage at this point, but they were expressing that it will be one day transparently communicated: *"Of course, with our partners we are communicating openly about the lifecycle impacts of our product, but in a way, we have not opened that up for the public yet."*

From these companies, only Company H had a focus on customer products. Other companies focusing on business to business (b2b) markets were providing consumable materials for reprocessing, the initial goal for this brand creation and communication is guiding the consumers take notice on environmentally more beneficial alternatives and guiding their buying decisions. Environmentally friendly branding provides premium pricing for companies, like the CEO of Company A revealed: *"And then this brand idea means that the consumers are ready to pay some extra for the environmental benefit."* Environmental benefits emanate from the reduced environmental footprint of companies' production and replaced less sustainable materials.

"Developing scale-up solutions"

Companies A, D and G were distinctly designed to be scaled-up globally. This occurred on the product features, as the materials were designed to be processed further with existing production infrastructure: *"Probably for bigger volumes we will produce the staple fiber, and someone will reprocess that further to yarn and cloth with their existing processes."* (CEO, Company D). These material innovations aiming to be scaled-up do not require extensive investments on current machinery or production facilities: *"Our materials can be processed with existing technological processes, so that we do not have to build any plant."* (CEO, Company A).

Common for these scale-up solutions with existing infrastructure was that they are occurring in strong cooperation with the partners in development of the material either in supply chain or with customers, or with both ends together, like the CEO of Company G illustrated: *"From a basic supply chain perspective, we are trying to find partnerships with our raw material suppliers, we are searching a model with them. We are doing joint development projects, because we know that through those we are able to widen our resource base. On the other hand, we are also cooperating strongly with, for instance, these package manufacturers, because we have new material, so then together with them we are discussing how Company G's product should be manufactured, what is the most effective model."*

Economic value for the scaled-up solutions would come from licensing. It was not in the short-term plans for every company, but it was definitely included in the future plans: *"So, in that regard, if we get this technology commercialized and successful in the best possible way, this technology has business potential, which Company G cannot fulfill alone. Then the business model of our second wave is based on licensing, on sales of knowledge and services."* (CEO, Company G). Companies A and D expressed that in the long-term new solutions can become price competitive against other materials.

Externally, scaled-up solutions will contribute to environmental wellbeing by the production of more sustainable products. The value for partners was explicitly recognized, as the raw material suppliers benefit from increasing demand of renewable raw materials as well the customers, who can have new products in their portfolio for their customers gaining competitive advantage: *"And now if we in the end license, for instance*

the use of this our material to plastic producers so that it means new business for them, they will undoubtedly get new customers, or new business from existing customers, or can hold on to their current customers, who would otherwise change to someone else, who has the eco-product. (CEO, Company A).

"Creating value from waste"

It appeared that creating value from waste was for Company F in the center of one of their product: *"...here we have sawdust as a raw material, which is a by-product in spruce saw mill. From it we produce a product with quite high added value."* The CEO from Company G expressed that they have a potential to use recycled materials as raw materials, yet due to existing recycling system it is not possible. Representative of Company H told that they recycle and reuse waste materials into new products. All in all, the proposition was turning waste into higher value products.

Company F's only source of raw material was the by-product of saw mills, while Company H created new products from waste materials and products: *"And all materials are grinded, or if there are waste products, then they will be turned to new products, so nothing is discarded."* (Export Manager, Company H)

Either one of those companies did not underline any added economic value from these operations, but it can be concluded that in the case of Company H reducing own waste reduces also raw material costs. Value for key holders in the case of Company F was reducing their waste management problems, as the CEO of Company F expressed: *"And actually in many sawmills the further processing/disposal of saw dust is a problem at the moment. It decomposes quite badly, so that is the problem."*

It can be also concluded from the principals of circularity that reducing the need of virgin raw materials preserves the nature and that way contributes to environmental benefits, although this was not highlighted by either of the company representatives.

"Encouraging sufficiency"

"Encouraging sufficiency" archetype by its name emphasizes reducing consumption and production of goods. Although, Companies G and H highlighted their products'

durability qualities compared to alternative materials, their overall business model cannot be found to implement this archetype, as it demands more radical influence on consumption and production.

"Delivering functionality, rather than ownership"

There was not identified any codes relating to "delivering functionality, rather than ownership" archetype. Majority of examined companies still has physical products to sell. Although Company E is providing also services, its main product is still enzymes, which they develop for their customers.

"Re-purposing the business for society/environment"

"Re-purposing the business for society/environment" archetype emphasizes societal and environmental profit over economic profit. Among examined companies, no one really had this approach in their business. Although Company D defined that sustainability is main driver for them, they are still executing profit-oriented business: *"We are trying to bring more environmental friendly solutions to the market, to produce these kind of textile materials or that kind of products compared to the existing (alternatives). That is the main driver, but then like of course we still believe that it can also be competitive by its costs."* (CEO, Company D)

4.3. Business models of individual companies

Some of the companies had not yet launched or sold any products, but were in the development phase. Thus, in some cases, the business model was still shaping hand in hand with the development of new products/services. However, by means of interview questionnaire designed to probe three components of business model, strategic visions, reflected from the interviews, enabled to compose a business model for each company. All the business models by companies are listed in table 2. All the following quotes presented in this section, verifying the findings, are from the representative of treated companies. Additional information was also searched from the corporate websites.

Company A

In the core of Company A's business model value proposition is biodegradable, transparent packaging material, which can be scaled-up and reprocessed with existing production infrastructure (Table 2). The material is directly competing with petrochemical products, but it is also having competition from alternative bio-based materials. However, the competitive advantage is not only in providing a more environmental but also in overall more sustainable alternative: *"And the problem of these bioplastics usually is that the production requires agricultural land, where food could otherwise be produced. And the world's demand of food will grow 50% in next ten years. And if the agricultural land is used to produce bioplastic, we are solving one problem but creating a new one. We do not have this problem. We do not compete with food systems."*

This advantage is accomplished from raw material side. As a raw material, Company A uses wood cellulose, which origins are from third party certified forests. The use of forest-based raw material in transparent packaging solutions is possible because of new, secret, manufacturing technology: *"But basically, we start out with tree trunk and with something else, and then comes the "black box", then we have granulate."*

Company A manages a wide network of partners. They use external services in the development of production technology and in other business operations. Development of their products and scaling-up is done together with partners, who provide production capacity and have experience in reprocessing functionally similar materials into different packaging solutions: *"Then the value chain, which by its name creates that value, it is that they (the partners) have those investments and capacity and decades or maybe hundred-year know-how on how to do these things."*

The wide partner network lightens company's fixed cost structure and reduces the need of big investments. It also creates the competitive advantage for the partners, as they will have new eco-product in their portfolio. It was expressed that the beginning of the value chain also benefits from growing demand of renewable raw materials. Strengthening the environmental aspect by branding the new material, Company A tries to guide customer's buying behavior and get higher price for their products.

Concerning the environmental values, Company A tries to provide solution to the Earth's plastic waste problem by replacing the plastics with their wood-based biodegradable material. As quoted before, they also provide bio-based solution, which does not directly compete with food system or arable land.

Table 2. Companies, business model components and archetypes

Company	Value proposition	Value creation and delivery	Value capture	Archetype
A	Biodegradable packaging solutions: compatible with existing reprocessing infrastructure, possibility to scale up	Resources: Renewable, certified raw materials Partners: Research and production outsourced, product co-creation Technology: New production technology, but compatible with existing	For company: Higher price from branding, lower costs from outsourcing services, no need for big investments for new production infrastructure, lower raw material costs for big volumes For others: Competitive advantage for partners, additional incomes for industrial partners, influencing customers' buying behavior, reducing plastics, no competition with food systems	Substituting with renewables and natural processes; Adopting a stewardship role; Developing scale-up solutions
B	Recyclable wood composite designer product family	Resources: Combination of renewable raw materials from existing suppliers Partners: Strategical production partners Technology: New, less polluting, more efficient and safer production technology	For company: Incomes from wide product selection and new market areas, higher price from branded product design For others: Reducing environmental stress in production	Maximizing material and energy efficiency; Substituting with renewables and natural processes
C	Natural health product	Resources: Moderate amounts of unique renewable raw material supplied by freelancers Partners: Production chain semi-outsourced	For company: Incomes from unique qualities and affordable price For others: Improving users' quality of life and reducing their expenses, preserving nature	Substituting with renewables and natural processes
D	New recyclable textile fiber material: compatible with existing reprocessing infrastructure, possibility to scale up	Resources: Renewable certified raw materials from existing suppliers Partners: Product co-creation with industrial shareholders Technology: New, more efficient and safer production technology	For company: Higher price from branding For others: Additional incomes for industrial partners, reducing environmental stress in production, by substituting climate change mitigation and free of microplastics	Maximizing material and energy efficiency; Substituting with renewables and natural processes; Adopting a stewardship role; Developing scale-up solutions
E	Technical solutions and supporting services to bio-industry	Resources: Bacterial based Partners: Production outsourced, proactive operator in new value chain co-creation Technology: Fast industrial-scale solutions	For company: Incomes from new markets and faster service, lower costs from outsourcing services For others: Reducing environmental stress in production, creating jobs	Maximizing material and energy efficiency; Substituting with renewables and natural processes; Adopting a stewardship role

F	Management of R&D concepts: natural health product	Resources: Moderate amounts of renewable by-products/waste as raw material Partners: All operations out-sourced, management of partner network	For company: Incomes from selling or licensing product idea, lower costs from out-sourcing services, no need for big investments for new re-search infrastructure For others: Reducing social inequity and improving users' quality of life, preserving na-ture and reducing wastes, re-ducing development costs and risks of customers	Creating value from waste; Substituting with renewa-bles and natural processes
G	Recyclable pack-aging solutions: compatible with existing repro-cessing infrastruc-ture, possibility to scale up	Resources: Combination of re-newable raw materials from exist-ing suppliers, potential to utilize recycled materials Partners: Shared infrastructural services and product co-creation Technology: New, more efficient production technology	For company: Incomes from improved qualities, smaller unit costs, lower costs from shared infrastructural services For others: Reducing plastic and environmental stress in production	Maximizing material and energy efficiency; *Creat-ing value from waste (po-tential)*; Substituting with renewables and natural processes; Adopting a stewardship role; Develop-ing scale-up solutions
H	Recyclable wood composite de-signer product family, re-pro-cessable material with existing die-cast machinery	Resources: Combination of partly renewable certified raw materials from existing suppliers Partners: Raw material suppliers Technology: More efficient pro-duction technology	For company: Revenues from unique qualities, wide product selection and export For others: Reducing environ-mental stress in production	Maximizing material and energy efficiency; Creat-ing value from waste; Sub-stituting with renewables and natural processes; Adopting a stewardship role

Company B

Company B's innovation and the ground of their design products is new recyclable wood composite material with special features. They are confronting direct competition from ceramic products. Indirectly, as there is not yet the similar products in the market, they are competing against other bio composite materials. Yet, they are distinctly standing out from them with their unique look and design: *"Then in a way the look of the material comes from the wood chips inside the composite, versus for example the traditional terrace planks etc., which are made from stained plastics, and the surface gets its looks from the plastic used. For us the look explicitly comes from the wood, the authentic material. And then we of course try to use bio-based resins, so that we could get the whole product from renewable raw materials, and then it is designed in a way that it can be recycled as waste-to-energy, if it is not needed anymore."*

Compared to production of competitors, this new production technology is claimed to be safer, it does not require that much energy or water and it does not pollute the air. Product development is in-house and the production plant is in Finland with strategical partners. As their renewable raw materials are purchased from the existing markets,

their new production technology is enabling to acquire their unique look and competitive advantage: *"So, we produce them in the way we have now learned, and there has been quite a lot effort in developing our own production technology. We have our own mold technology."*

The revenues are coming from the market area, where there are not similar materials on sale yet. It was expressed by company representative that to adjust into the markets they need to have wide product selection, the new material is not enough in a long term. They are seeking higher price for their products from branding and design: *"(the goal is) To build a brand, which everybody recognizes, and which would be known because of this material and this kind of surprising designs…"*

Environmental benefit is accomplished through displacing the stressing production of ceramics. Advantage of transportation of lighter products was mentioned in passing: "*The density is about one and ceramics has something like 2.2, so it is lighter, almost half of its specific weight. There will be some benefits related to logistics, but that was never... it is just great that it happens to be so."* However, it can be assumed reducing not only the costs of transportation but also emissions.

Company C

Company C has developed new health product on the grounds of scientific finding on tree resin. They are competing with chemically produced alternatives, and as well with other natural products. However, attributes of their raw material give them unique combination creating competitive advantage: *"There are other products in the market as well, but none of those products have this kind of combination, where you have all of them. It is a kind of all-in-one type of product."*

Company C have semi-outsourced supply chain and production. This renewable raw material is collected by freelancer. Company produces the active ingredient itself, but the final tubing and labeling is done by outsourced partner.

From economic perspective, they have positioned themselves so that their main product's price is cheaper than by their competitors. Taking into consideration that they offer wider number of qualities compared to competitors, they feel that their product would become cheaper for society: *"But still even though we consider all of these*

factors, then still in my opinion, the product is affordable and would be cheaper for the society."

CEO of Company C saw that they do not have environmentally that much neither harmful nor beneficial contribution. They felt difficulties in designing their end-products to be recyclable. However, it was expressed that the raw material collection preserves the nature, and collected and transported amounts are moderate: *"I talked about this, that we collect the tree resin without harming the trees. There in the north the active ingredient is produced and brought here to Southern Finland, where the sales are bigger. So smaller amounts are transported [compared to transporting completed end-product]."* Contrarily, a social aspect was highlighted more to be in core of their values, when improving customers' health: *"So, the social benefit is the number one thing, we will improve people's quality of life."*

Company D

Company D has new production technology, which enables production of new forest-based recyclable textile fiber, which can be reprocessed into end-products by existing production infrastructure. The competition is with different textile fibers, which are produced from both bio-based and oil-based raw materials. However, company's competitive advantage comes from their more sustainable production technology: *"The alternatives are probably all the existing of course, like cottons and polyesters and viscose. The fact however is that these existing (alternatives) will not be enough to satisfy the demand in the future, which means that something new must be brought to the markets.*

New production technology enables them to manufacture staple fiber from pulp, made of third party certificated wood (provided on the website), with more sustainable process, which is safe and does not require that much resources or chemicals: *"But we can completely skip this kind of difficult chemical process and with a clean mechanical process produce from pulp this kind of staple fiber suitable for textiles."* It is also found from their website that production process does not create any waste, so that it can be regarded as closed process in that sense.

In addition, with different textile brand owners, who will produce the end-products, Company D has their key partners as shareholders of company and this way they are

more in-depth involved in the development process. Together they are developing the technology based on partners' raw materials. At the moment they are producing fiber themselves, but as their goal is to scale-up the technology. In the future option is either to found co-owned company with partners or to license the technology: *"Well, in that perspective our business model is still flexible, we can of course be ourselves the fiber producer; we can license the technology to someone; or then we have for instance, as a goal with Company X to found a co-owned company which will produce the fiber."*

Examining the website of company, it is clear that the sustainability is in the core of their business and the biggest driver. Sustainability impacts are transparently communicated on their website and referred to United Nations sustainable development goals. In the operations they are making sure that the sustainability value is conserved throughout the entire supply chain.

They believe that the product can in a long term become cost competitive compared to its' alternatives, but clearly this open communication and branding can be concluded to aim to premium pricing. In respect of partners, creation of new value chains will lead to new revenue streams as well.

The environmentally less harmful production is the clearest environmental contribution emerging from the interview. However, the company communicates by means of the website that by substituting other materials they are not only part in the mitigation of the climate change but they also prevent microplastics ending in the nature.

Company E

Company E is offering technical enzymatic solutions for bio-industries, such as wood and paper industry. In addition to enzymes, these solutions include supporting services as well. They see that they do not have direct competitors from enzyme technologies, as other producers are concentrated on different markets. Yet, different mechanical solutions are regarded as competitors in the same sector: *"Well, there are different competitors in the wood and paper industry, we are competing against, for instance energy saving mechanical solutions in certain sectors. There are chemicals which are [competitors] in at the same sector. But often these are also solutions supporting each other in that way they are not always against each other. In enzyme production our*

competitors are of course these big ones, but as said, we are aiming to slightly different markets than they are."

The advantage compared to competitors is gained from different production base and service attitude, and from ability to get industrial-scale solutions quickly to customers: *"We are making that enzyme first and afterwards we will improve the production efficiency. And this has come out to be an extremely functional strategy. Then we get quickly to the market and directly to effective solution and then we can improve our margins. It is a remarkably faster route."*

Outsourced production capacity provides more dynamic organization structure and anyway the strong partner network is important for Company E. They are strongly involved in development of new value chains within bio-industries: *"But yes we are quite involved in cooperation and strongly networked explicitly to create new complete value chains from raw materials until customer products and to find, on the way, our spot in that chain."*

This strong partnering in production directly reduces the fixed costs of Company E. Yet, it also provides the profits achieved from the new market areas, where the new value chains are created, and where the Company E is central operator. As being a part of the creation of the new value chains in bio-industry, Company E accelerates the development of new more sustainable solutions. On their website, the company is advertising created environmental benefits through improving efficiency of their customers' operations, including energy savings, higher yields and less waste. Creating of new jobs thanks to new bio-industrial processes was mentioned as direct social value: *"It is also satisfying that the more we can bring these solutions to the European environment, the more we are creating jobs in the western world in the industrial sectors, from where they have disappeared lately, which is also social aspect."*

Company F

In the core of Company F's business model, there is development of new product concepts. These concepts include research and development of products. Fully developed concepts are sold or licensed for customers to commercialize. Selling point for their product development projects is Finnish high-quality research: *"Finland has the kind of reputation that studies done in Finland can be trusted. This is not in the case for*

every place. We take this kind of idea, which we call "proof of concept", and here are the study results, then it is probably seen abroad that it is indeed true and that the research done here is valid." In the interview was treated one of their product concept, which is health product produced from by-products of saw mills. They face competition from health products aim to treat same symptoms produced from other bio-based raw materials. However, based on my interpretation, their advantage is in more sustainable raw material: *"...it (raw material of competitive products) grows, this would go to this social sustainability, in the area where working conditions can be somewhat bad; the seed from which the oil is extracted it is collected and cleaned, I suppose or I understand, by hand. There are of course quite a lot issues related to sustainability, like in soya farming. Our raw material comes from a by-product of sawmill industry, so of course it is like totally different thing."*

Saw mills' by-product is thus enabling the production of high value health products from wood waste. The company is operating in a wide network of partners having outsourced nearly everything. Their operative work is managing the partner network: *"Yes, for us our partners or network of partners are very important. They are doing this research regarding the "proof of concept". This is about managing the network. And stockholders compose a kind of network to drive this project forward."*

As mentioned before, their revenues will start to materialize, when the ready-to-commercialize products are sold or licensed to another operator. Their light organization structure provides savings in fixed costs and reduces need for investments: *"The reduction of costs is very obvious, our fixed costs will remain very small and with that network we are able to keep our own employees and everything else, like costs, quite minimal. And then we can just purchase that necessary service we are needing. If we need some laboratory service, we can buy that from someone without investing in our own laboratory and personnel, which would otherwise be employed whether there is something to do or not. So that is remarkable cost saving."*

The external values from their "proof of concept" business model can be found to be reduction of product research and development risks and costs of their partners. By their health product business model, they are reducing the problematic waste of their partners, clearly improving the users' quality of life and preserving the nature in raw material supply.

Company G

Company G has developed a new paper- and plastic-like packaging material produced from wood fibers. The material is designed into existing recycling system and to be reprocessed with existing production infrastructure. The competitive materials are existing packaging materials, such as paper, bio-plastic and plastic. The advantage over competitors however is that new technology provides unique qualities for their product: *"Well in practice the competitive advantage of our product, or this Company G's material, is based on the fact that we have been able to improve the performance of the product through this new production technology. In practice what that performance means is that we can use less materials, we can produce materials with lighter environmental burden or with using less water, energy; we can replace hardly recyclable materials in the markets, so that our product can be recycled."*

New production technology requiring less inputs combined with exiting renewable raw material supply enables the more sustainable alternative over competitors. They revealed that the technology has also the potential to use recycled raw materials. Yet, the recycling or supply system of recycled raw materials is not at the required level to be utilized. Currently production is their own and growth of capacity is done alone at first. However, the aim is to scale up the production with partners and at some point, licensing is considered to be part of strategy.

Company G is developing the material together with both ends of the supply chain, raw material suppliers and re-processers of the material. They are searching industrial symbiosis with partners to share infrastructural services and to keep their organization as dynamic as possible. This contributes to reduce both fixed costs and need for huge investments: *"…we can make our model much more effective through this kind of model. We will keep the fixed costs of the new level business as light as possible."* Other economic values recognized from the business model of Company G directly comes from using less raw materials for each product unit. Of course, the unique performance of sustainable material creates demand and incomes as well.

The value from environmental aspect emerging from the interview was substituting plastics and reducing environmental stress in production. In their website, the company is underlining that their material decreases the ocean pollution. Company is keeping track of their lifecycle impact and sharing it with their partners. They also guarantee

the sustainability of the entire supply chain by having a code of conduct procedure in use: *"At the moment we actually have the code of conduct procedure, that what we are using, for instance when selecting these partners of ours. On the other hand, that when our whole business model is based on this kind of responsibility and environmental friendliness, updating the lifecycle assessment at regular intervals is a part of the program."*

Company H

Design product family of Company H is made from new recyclable wood composite material. The composite material can be die-casted with regular machinery. The competitive materials vary from wood and other bio materials to porcelain and metals. The advantage of new composite is based on different qualities, such as durability and lightness compared to other materials. Additionally, it is more ecological material: *"But of course, it is a more ecological alternative. It can be washed in the washing machine. And it is light, durable and then… well the idea is that it will last for a long time, that there is no need for getting rid of it. The idea is that, if you at some point want to discard it, then you can burn it for instance, or you can recycle it. We can produce a new product out of it in our production, or it does not… from there continues its life."*

The advantage comes from the re-processable wood-based material and efficient production technology. In addition, company uses renewable energy in their production. They are paying attention to manufacturing processes to have zero waste: *"We were Finland's first company to use green electricity already in 1998, long before natural fiber composites and Product X. Recovered heat is used to heat the factory. And all materials are grinded, or if there are waste products, then they will be turned to new products, so nothing is discarded."*

Although, half of the composite contains polyethene, the product is recyclable to energy or back to raw material. Company has assessed their product's lifecycle impacts and it only have small carbon footprint from use.

Finnish design is strongly present in their communication on the website. Part of the incomes of wide product family come from export sales.

Contribution to environment is based on the zero-waste production and longevity of products: *"The usage of the cup is more consumptive than the actual production or discarding. The emissions from the production are zero."*

During the interview did not occurred remarkable social contributions, but on their website company tells, how they support the work of international welfares and sponsor local events.

4.4. Business model components

Value proposition

All of the companies had a physical product to offer for their customers. However, the Company E's solution included also the supporting technical services. The Company E differed also by the base of its product as it is made out of bacteria, not from forest biomass. However, their link to forests is in customers, as they are providing enzyme solutions for forest industry among for other bio industries to develop new more efficiency solutions. Company F on the other hand has two different products. They are developing research and development concepts to be commercialized by their customers. One of those concepts is based on scientific finding in forest-based raw material. Companies B, C and H are concentrating in the business to customer (b2c) -markets, while rest of the companies in the business to business (b2b). Companies A, D and G are producing materials for reprocessing by other operators, and as it appeared they are aiming to scale up their business. Their materials are designed to be reprocessed with existing production infrastructure supporting their scaling-up goal. The material of Company H is also re-processable with regular die-casting machinery. All the companies providing physical consumable products have designed them in respect of current recycling system. As has been mentioned companies not just aim to replace non-renewable materials but they are also replacing less sustainable materials. On top of that, the new production technologies are claimed to be more efficient, non-toxic, less polluting and less demanding in resource perspective.

Value creation and delivery

Resources

Although examined companies were selected to represent a merged concept of circular economy and bioeconomy, and their products are recyclable, yet only two of them are using waste as their raw material and from these two, only one as the only resource. Others produce their materials or products from virgin forest resources. However, Companies A and G expressed that they are considering also the use of recycled materials, if there would be such possibility. Like mentioned before, three companies communicated either during the interview or on their website that they are using certified raw materials**.** Production technology of the Companies A, D and G is based on the use of wood cellulose. Companies D and G are using pulp suitable for paper industry. Only the Companies C and F are not using existing raw material suppliers.

Partners

In the operations of examined companies, key partners are more or less present in various steps. Organizational structure of Companies A and F is heavily based on the services of partners and their business is more like the management of partnership network. They have both outsourced their product development for the partners: *"And the reason why there are only two of us is that this business model… or will it come here later… but it is based on the fact that we are using external outsourcing services to take these researches further."* (CEO, Company F), *"From the beginning VTT has just been our technology partner and we have sub-supplied the knowledge of certain persons from them."* (CEO, Company A) From the interviews emerged that almost all the companies in the b2b -markets are developing their materials or products together with their customers. For the Companies A, E and partly for C, partners provide production capacity reducing investments in own infrastructure. Company G is also seeking partnership advantages from shared infrastructural services. Their goal is to found industrial symbiosis. Economic benefits from partnering were seen to be in savings on the fixed costs enabling to have more flexible and lighter organization: *"The reduction of costs is very obvious, our fixed costs will remain very small and with that network we are able to keep our own employees and everything else, like costs, quite minimal. And then we can just purchase that necessary service we are needing. If we need some*

laboratory service, we can buy that from someone without investing in our own laboratory and personnel, which would otherwise be employed whether there is something to do or not. So that is remarkable cost saving." (CEO, Company F). All in all, importance of partnering with global industrial companies stood out clearly from the interviews of those having operations with them. CEO Of Company A summarized the value of their partners: *"The value is central, without these our partners, we could not even try this project or without our partners this our innovation could not be turned into business."*

Technology

New materials of Companies A, B, D and G is based on the new production technology. Production technologies of Companies B, D and G is told to be less resource demanding, and anyway more sustainable than their competitors. Companies C and F do not employ new production technology but they do have research findings enabling the use of their material properties. Company H did not reveal whether their material combination is based on new production technology or not, but it is processable with die-casting technology.

Value capture

For company

Here, it is pointed out the most frequently occurred codes based on the interviews but also the companies' websites. Companies A, B, D, G and H are distinctly separating themselves from the competitors by sustainability brand. Of course, the sustainability is genuine concern among all companies, but still it is way for them to get premium price from their solutions. For Companies A, D and G, the aim is to get their products to be price competitive against alternative materials. The CEO of Company A expressed that it could whether be cause from increasing demand of raw materials causing the costs to drop, or from sanctions on unsustainable materials. Most frequently appearing code on cost reduction was the partnering

For others

Value for environment appears in reduction of environmental footprint in production compared to other materials – in other words from smaller environmental footprint. Other environmental values are in reducing waste ending to nature or in the landfield as almost every consumable product examined in this study was designed to be recycled or biodegraded. Companies D and G stated that they ensure that whole supply chain is sustainable. Company G has Code of Conduct procedure as a tool for supervising their partners to follow the sustainable development "rules". Company H is the only company providing the specific information on their contribution to society on their website.

Internationalization

Companies can be separated into two groups by their global strategy. Those who are already operating in the global markets or born directly there, and those who are seeking growth from export sales keeping their production on themselves.

Companies A, D, E, F and G are seeking customers abroad. However, there was slight variation between these companies, how to operate in the global markets. Companies A and E have their production outsourced abroad. At the moment, Company D and G have their production capacity in Finland, but they are cooperating globally with their partners and seeking to scale up their production through co-owned production capacity (Company D) or licensing: *"...we can of course be ourselves the fiber producer; we can license the technology to someone; or then we have for instance, as a goal with Company X to found a co-owned company which will produce the fiber."* (CEO, Company D).

While Companies A, D, E and G are developing their solutions together with international partners, the company F is managing development of their product in Finland and seeking abroad for customers, to whom sell or license the whole product idea. That is because there are not such customers in Finland, who they see potential: *"In Finland there is not that kind of company, which we would see as a potential client."* (CEO, Company F). However, their selling point or competitive advantage for their products is that they have been developed by trustworthy Finnish research.

Companies B, C and H are also seeking growth abroad. However, they will do it by export sales. From these companies, the company H already have strong roots abroad and they are selling their products approximately to 30 countries all over the world. Company B strategy is to grow into international design company. They did not explicitly mention about export sales, but at least in the early stages it can be concluded from the interview as they will have production on themselves. Whereas CEO of Company C told during the interview that they are working to get their product abroad: *"Our export sale is very small at the moment, but we are working hard so that we would bring this abroad."* (CEO, Company C)

4.5. Challenges and opportunities

The final 13. question was explicitly formed to probe future challenges and opportunities among the companies' businesses or in circular bioeconomy. Although every representative did not have anything to predict, certain similarities were emerging from the interviews.

A commonly identified opportunity among Companies A, D and G was growing demand for new sustainable solutions. It will either be due to sanctions or taxation on other materials, like the following quote demonstrates: *"And of course, there is the direction that at some point the use of plastics is punished as well. Surely the oil, at some point the crude oil price will rise, but then there will be different kind of sanctions on the use of plastics for instance in form of taxes. And then these bioplastics will be price competitive."* (CEO, Company A), or just simply because current materials cannot satisfy the future demand: *"The fact however is that these existing (alternatives) will not be enough to satisfy the demand in the future, which means that something new must be brought to the markets."* (CEO, Company D). Demand for more sustainable solutions is also growing among industrial companies according to these companies. Many global companies are interested in developing the products for their applications, as the consumer demand is growing and they are getting more conscious on sustainability of products creating the selling point for these companies: *"We are delighted to notice that we do not necessarily have to point out to industrial operators that consumers are interested; as industrial operators, for instance food industry*

brands, are already hysterically interested in these new solutions." (CEO, Company A)

Future challenges varied more between the companies. Few most prominent challenges raised were financial issues, lack of dialogue or cooperation, and current recycling system. Representative of Company E was criticizing the financial support on development phase of new products. It was argued that funds for the phases after the research are critical for new value chains: *"…the emphasis of research and development are heavily on the research in Europe and Finland, and if we cannot invest in market demonstrations, piloting and commercializing with proper financing, then it practically means that we are paying for our education and research and wait that American and Chinese companies come and buy out these good companies, and then those jobs and the money disappear from Europe and Finland."* Representative of Company A had slightly different view on financial challenges arguing that the issue is who "pays the bill" from new more sustainable technologies: *"All the time, in the end, the question is about money more than the technology, who pays a packet. And then the consumer will pay it. If you follow the value chain long enough, at the last node there is always the consumer, to whom the costs should be somehow transferred."*

These companies also raised a concern towards the lack of cooperation and dialogue between different operators. Both argued that it is crucial to get every operator in dialogue through the whole value chain: *"That challenge will be clearly that in this value chain there are so many different operators, who must be in dialogue with each other, and execute mutual decisions."* (CEO, Company A). Representative of Company E also criticized the reticence of big operators and emphasized that everyone should be involved to solve these issues.

Current recycling system was raised as both a challenge and an opportunity by the Companies A and G. The representative of Company A expressed that new more sustainable solutions are not the only answer to tackle the environmental issues facing the Earth in the future: *"How this is handled, so like more than half of the resolutions will take place in the waste management. We need some kind of global protocol to that, how the waste is collected and sorted and reused and so on."* Currently the

system does not provide constant raw material streams to use. However, the representative of Company G saw that in the future it could provide it: *"Due to that the availability and this sort of qualitative homogeneity of that textile fiber is not yet at that level… we do not see that it would now be at that level. Possibly after 5 – 10 years it will be at that level. Probably we would have also totally new products in manufacturing based on this kind of circular economy concepts, meaning we are using recycled raw materials as our materials."*

Challenges related to circularity of the products was addressed by the Company G's CEO explaining that due to characteristic of their product, designing take-back system is impossible: *"Because for new material aiming at international markets it is difficult to build the business model based on, for instance, taking back and collecting the material, because packaging materials are spread/dispersed so widely."* On their website Company H raises a challenge towards legislation, which denies the usage of recycled material in products in contact with food.

5. Discussion

The companies analyzed were small, most of them startups, and still at the stage of product and business model development. They relied on R & D subsidies, while their turnover was negligible or still small. Then again according to Hansen (2016) the bioeconomy itself is still in the early phase. This raises the question; will these startups and their business models still exist in a few years. In business literature, this phenomenon has been observed as "the valley of death", because financial resources available for companies decrease when moving from the research and development to the commercialization phase (Branscomb and Auerwald, 2002).

Surprisingly none of the examined companies had a background in typical forest industry activities, such as sawmill or pulp industry. One company was, however, spun off from the research project of the Finnish forest cluster (i.e. diverse network of forestry experts and businesses). Hansen (2016) argued that this not uncommon, since the forest sector is generally mature and resistant to change. As a result, "it is often startups or companies outside an industry that typically introduce radical innovation" (Hansen, 2016, p. 241).

The initial development of several companies was linked to a national research institute, either because they were established after a research project or because they were purchasing services from it. Similar observations on the importance of cooperation with research institutes on new product or business model development was noted in the study of Manninen et al. (2018). Hansen (2016) and Reim et al. (2017) also highlighted research cooperation and the role of innovation system to be valuable in creating new bioeconomy value chains.

Since the examined companies were selected to represent forest-based circular bioeconomy products and services, it was expected that "Substituting with renewables" archetype would be a dominant archetype. However, it was found that the sustainable business model archetypes lack of the possibility to address the sustainability issues in relation to renewable materials, such as competition with arable land or enormous water usage. The archetype "Maximizing material and energy efficiency" was also found in several companies, promoting the innovations in production processes, which are designed to be more efficient, and which enable the use of new forest-based materials.

The archetype “Creating value from waste” was identified in only two companies. Many of the examined companies had designed their products in respect to “cradle to cradle”, or open-loop cycle in the case of biological nutrients (McDonough and Braungart, 2002; Bocken et al., 2016), so that products would either be biodegraded or be recycled as paper waste or energy. However, this did not completely fit the definition given by Bocken et al. (2014), according to which this archetype is about the use of waste as a raw material. Availability of recycled fibers in Finland is limited due to small population size; the majority of the manufactured paper and pulp is exported (Recycled fiber is…, 2017) thus causing the use of virgin fibers as a dominant base for industrial activities.

The ideal number of recycling events in the lifetime of a bio-based products (cf. cascading of biological materials before ending to energy recovery) is poorly discussed in the available literature. Bezama (2016) pointed out this paucity of information in his editorial on the implementation of circular economy and bioeconomy, suggesting that dialogue between product designers and waste industry should be enhanced to develop alternatives for energy recovery. Antikainen et al., (2017) argued that circularity principles are not yet explicitly embedded in the bioeconomy. Only some elements of circularity were found in the business models of the interviewed companies. The only elements found were recycling and recovery (to energy), while missing the elements of reduce, reuse, repair, remanufacture. On the other hand, Bocken at al. (2016) observed this to be typical for product of consumption.

Concerning the archetype “Adopting stewardship role”, it is difficult to draw a line between marketing communication and genuine operations to achieve greater sustainable impact. Almost all examined companies could be categorized into this archetype, seeking competitive advantage from eco-labeling, proposed by Reim et al. (2017) as a strategy for the bioeconomy to strengthen customer relationship. The companies categorized into “Adopting stewardship role” archetype expressed either during the interview or on their website operations to assure the sustainable value chain through third party certified raw materials and/or lifecycle assessment. Forest certification has been recognized to combat deforestation and illegal loggings (Damette and Delacote, 2011), and the two largest third-party certification schemes FSC and PEFC (UNECE/FAO, 2016-2017) ensure socio-ecological sustainability of the raw material (PEFC-metsäsertifioinnin kriteerit, 2014; FSC Principles…, 2015). Yet, it can be argued

should the lifecycle assessment be included as a criterion for comprehensive sustainability in "Adopting stewardship role" archetype. Out of three companies which claimed to have done a lifecycle assessment, only one company provided the full lifecycle assessment report on the website of the company. The report calculated the environmental impact of the product's lifecycle, but questions remain about the social impacts of lifecycle assessed by the companies. According to Mattila et al. (2018), there are no tools for social lifecycle assessments integrating both local and global scale impacts in the bioeconomy. This leaves a gap in terms of measuring social impacts.

Contrary to what found by Oghazi and Mostaghel (2018) in regard to circular economy business models, service-based archetypes, such as "Encouraging suffiency" and "Delivering functionality, rather than ownership", were not identified among the circular bioeconomy business models in our study. Longevity of products, in the case of two companies, was considered more like a competitive advantage of bio-based materials compared to existing alternative, but it was not seen from the viewpoint of influencing consumption levels. None of the companies offered repairing services; most of the examined companies were rather developing disposable solutions from forest biomass and the value proposition in many cases was to replace unsustainable materials.

When comparing the groups of the archetypes, it appears that technological models were distinctly predominant over social and organizational models. This can be the result of sampling but similar observations (i.e. insufficient radical transition to service-based business models) within the circular economy and the bioeconomy have been made earlier by Bocken et al. (2017) and Pelli et al. (2017). According to Bocken et al. (2017, p.489) the circular economy suffers from "a very slow uptake of more "radical" forms of circular business model innovation, such as sharing models (e.g. peer-to-peer)", while Pelli et al. (2017, p.13) found in their analysis "an incremental rather than radical" increase of technology-based services in forest-based industry. As also observed by Pelli et al. (2017), the increased role of partner network providing external services in forest-based industries emerged from this study as well.

Overall, it appears that the recorded archetypes do not sufficiently promote the sustainable forest-based bioeconomy, not to mention the forest-based circular bioeconomy. As also stated by the CEO of Company A, substituting with renewable resources does not directly result in a more sustainable outcome.

Despite the heterogeneity of the sample, there were a lot of similarities in the business models concerning the companies aiming into the same b2b markets. Companies A and G both had new renewable packaging solution for industries. Company D was aiming into other b2b market with its solution, but still its business models had similarities with Companies A and G. Companies were more born global type startups and their solutions were designed to be reprocessed with existing infrastructure and they ensure the sustainability of the value chain. Only distinct difference occurred in the establishment motivations. While Companies D and G were spin offs from projects led by a national research institute and the motivations based on new technology, Company A was established based on the environmental value proposition.

Other similarities between business models were found among Companies B and H in b2c markets. Design products from new wood composite material were in the core of their business models, both aiming to export. Differences between companies were found in regard to circularity design. Unlike Company H's product, Company B's product was made completely out of renewable materials. However, Company B's raw material was from virgin resources and the energy recovery was only suggested as an option in the end of the lifecycle. On the contrary, Company H's product could be produced from the waste of old products, extending the material circularity.

In regard to the components of the identified business models, it is challenging to compare the results to prior findings, as there was not found previous studies concerning the circular bioeconomy business models. When comparing our results to the circular economy business models by Manninen et al. (2018), parallel and dissimilar environmental value propositions were found. Manninen et al. (2018) composed the value proposition for one company producing wood stones from recycled wood fiber to "Reclaim, retain and restore health of ecosystems". This kind of approach can be found in the propositions of every company in this study as well, as it is strongly linked to the idea of "Substituting with renewable materials". Other propositions: "Increased share of recyclable and recycled materials that can replace the use of virgin materials";

"Minimized and optimized exploitation of raw materials, while delivering more value from fewer materials"; "Incineration and landfill limited to a minimum", were only found in the business models "Creating value from the waste" archetype. Especially, the last proposition was present in the business model of Company H, offering to produce new products from the old product's waste, however this possibility is not actively highlighted on their website.

Modes of value creation and delivery varied between the companies. Notably, companies providing new forest-based materials are using existing raw material supply channels supporting the recent pulp mill investments news of forest sector in Finland. Similar findings were recorded by Hansen (2016, p. 238): "this translates to a switch in mentality from making paper first and selling the by-products second to making chemicals first and treating paper as the by-product". A report by the Finnish Environment Institute (Antikainen et al., 2017) signaled a concern towards sustainability of lifecycle of forest-based products and processes regarding the use of energy, hazardous chemicals and toxic additives. Although our study was based on the interviewees' perceptions, many companies were explicitly pointing out their production to be safe, non-hazardous, chemical free and energy efficient.

Cost-efficiency in production emerged as a goal for those companies aiming to scale-up their production. This is in line with the literature review findings of Reim et al. (2017), claiming that the cost-efficiency production is highlighted in the bioeconomy business model literature. As many examined companies were still developing their products without any concrete turnover, it was difficult to precisely identify value capture. The dependence on subsidies was not investigated deeply in this study, but we also found that, as stated by Reim et al. (2017, p.779) "many of the ongoing activities related to bioeconomy are heavily depended on subsidies".

In regard to future challenges for circular bioeconomy activities, from the interviews it emerged that the examined companies in the b2b markets or producers of perishable goods have no power to design for example take-back systems into their business model. Similar challenges were found in the study by Ormazabal et al. (2018) from Spain. Similarly, financial resources were raised as a challenge in their study.

Furthermore, Ormazabal et al. (2018) found that among Spanish SMEs challenges related to implementing circular economy operations include lack of support from public

or organizations and lack of customer interest in the environment. This is in contrast to our findings, which show that the government and national research institute support and promote the development of circular economy solutions, and the companies are well aware of growing customer demand for more sustainable products and services, both globally and locally, as also observed by Hansen (2016). A possible explanation for these differences is the different cultural and geographic context.

Importantly, we found that the interviewed companies do not have a strong perception to operate under a circular bieconomy (or sustainability) framework, but rather do business for the sake of business. This is in line with the findings of Bocken et al. (2017) done in larger scale analysis, which found that the companies do not communicate their operations to be circular economy. Similar findings emerged from a study by Ormazabal et al. (2018), according to which only some financial benefits are recognized to come from a circular economy for Spanish SMEs (Ormazabal et al., 2018, p.163).

While environmental value was well covered in the business models of companies, only one company provided quantitative information on their environmental impacts. In their study, Haffar and Searcy (2018) discovered similar shortage in relation between sustainability communication of Canadian companies and planetary boundaries. Like suggested by Haffar and Searcy (2018), it would be important for companies to set quantitative targets based on the framework of UN's Sustainable Development Goals to address the overall sustainability impact as it still appeared as if contribution to social value was taken for granted as a narrow outcome of economic and environmental values. Job creation and improving the life of people were the only recognized social values which emerged during the interviews.

External and internal limitations affect the generalizability of the results. External limitations include the amount of companies operating in the forest-based circular bioeconomy. For this study, companies were selected from a government-based website promoting export of Finnish SMEs under the circular bioeconomy framework. However, only a couple interviewees expressed familiarity with this novel concept. This might question whether using such website was the best sampling strategy. Certainly, additional circular bioeconomy companies also exist outside this government pro-

moted program. Also, despite the purposeful sampling, companies are a rather scattered group operating in different business areas, which represents a challenge to the homogeneity of the analysis.

The final sample size is also rather small, as from a preliminary selection of 13 companies, eight companies were eventually interviewed. Since the selected companies were very small, we only could interview one person per company, while for instance Oghazi and Mostaghel (2018) were able to interview two or three representatives from six circular economy companies in Sweden. This hampers the possibility to validate and compare interviews conducted within the same company. Nonetheless, we considered the data sufficient for an explorative examination of this emerging phenomenon.

6. Conclusion

The results from this thesis provide insight into the development of new business models within the forest-based bio-innovations in Finland. The interviews with SMEs managers revealed that business models vary a lot between companies, actually including features from several sustainability archetypes. However, if the forest-based circular bioeconomy business model was to be summarized into one dominant model, its value proposition would be replacing unsustainable materials; value would be created and delivered using forest-based raw materials by new production technology within strong network of partners; value capture for the environment would be reducing the environmental footprint in production, while seeking direct savings on fixed costs from partnering. Overall, the identified models were dominated by traditional practices (e.g. eco-efficiency), while more radical principles, such as prolonging the material cycle before incineration, were often missing. Nonetheless, it is too early to draw ultimate conclusions on the business models of the interviewed companies, since they were still at an early stage of development. This study concentrated on the circular bioeconomy transformation at the micro level, by looking at company business models. For further studies would be beneficial to examine the meso and macro level transformation to get a more holistic view on business environment, where companies with circular bio-product innovations operate. This would help revealing implementation barriers for the circular bioeconomy. More comprehensive studies could also analyze attitudes of key partners in the value chain, such as raw material providers, waste management operators, research institutes, customers and regulators.

The environmental contribution was well communicated by the companies, while the social benefits mentioned were limited to few direct impacts. To make sure that "sustainability" does not remain as a buzz word in the rapidly evolving startup environment, companies should more transparently account for their sustainability impacts within economic, environmental and social dimensions. We suggest that quantitative measures in regard to UN's Sustainable Development Goal framework could be used in the reporting of sustainability impacts to provide a broader overview of the company sustainability level. This could result in a competitive advantage for the companies, for instance from growing customer demand for sustainable products and services.

7. References

Allen, B., 2015. A step further. Horizon 2020 Projects: Portal. Issue Nine. 196-199. Available at. http://www.horizon2020projects.com/publications/ [Accessed February 24, 2018]

Anderson, C., 2010. Presenting and evaluating qualitative research. American Journal of Pharmaceutical Education 2010; 74 (8) Article 141. Available at. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2987281/ [Accessed May 15, 2018]

Antikainen, R., Dalhammar, C., Hildén, M., Judl, J., Jääskeläinen, T., Kautto, P., Koskela, S., Kuisma, M., Lazarevic, D., Mäenpää, I., Ovaska, J-P., Peck, P., Rodhe, H., Temmes, A., Thidell, Å., 2017. Renewal of forest based manufacturing towards a sustainable circular bioeconomy. Reports of the Finnish Environment Institute 13/2017. Available at. http://hdl.handle.net/10138/186080 [Accessed January 9, 2018]

Bezama, A., 2016. Let us discuss how cascading can help implement the circular economy and the bio-economy strategies. Waste Management & Research 2016, Vol. 34(7), 593–594. DOI: 10.1177/0734242X16657973

Bocken, N.M.P., Short, S.W., Rana, P., Evans, S., 2014. A literature and practice review to develop sustainable business model archetypes. Journal of Cleaner Production 65 (2014), 42–56. DOI: 10.1016/j.jclepro.2013.11.039

Bocken, N.M.P., de Pauw, I., Bakker, C., van der Grinten, B., 2016. Product design and business model strategies for a circular economy, Journal of Industrial and Production Engineering, 33:5, 308-320, DOI: 10.1080/21681015.2016.1172124

Bocken, N.M.P., Ritala, P., Huotari, P., 2017. The Circular Economy: Exploring the Introduction of the Concept Among S&P 500 Firms. J. Ind. Ecol. 21, 487–490. DOI: 10.1111/jiec.12605

Boons, F., Montalvo, C., Quist, J., Wagner, M., 2013. Sustainable innovation, business models and economic performance: an overview. J. Clean. Prod. 45, 1–8. DOI: 10.1016/j.jclepro.2012.08.013

Boons, F., Lüdeke-Freund, F., 2013. Business models for sustainable innovation: state-of- the-art and steps towards a research agenda. J. Clean. Prod. 45, 9–19. DOI: 10.1016/j.jclepro.2012.07.007

Braat, L.C., de Groot, R., 2012. The ecosystem services agenda: bridging the worlds of natural science and economics, conservation and development, and public and private policy. Ecosystem Services Volume 1, Issue 1, July 2012, 4-15 DOI: 10.1016/j.ecoser.2012.07.011

Branscomb, L.M. and P.E. Auerswald, 2002, Between Invention and Innovation: An Analysis of Funding for Early Stage Technology Development, Report to the Advanced Technology Pro-gram, NIST. Available at. http://www.cigref.fr/cigref_publications/RapportsContainer/Parus2005/Between_Invention_and_Innovation_-_NIST_-_November_2002_web.pdf [Accessed May 11, 2018]

Brennan, G., Tennant, M. and Blomsma, F., 2015. Chapter 10. Business and production solutions: Closing Loops & the Circular Economy, in Kopnina, H. and Shoreman-Ouimet, E. (Eds). Sustainability: Key Issues. Routledge: Earth Scan, 219–239. ISBN 9780415529860

Bugge, M.M., Hansen, T., Klitkou, A., 2016. What Is the Bioeconomy? A Review of the Literature. Sustainability 2016, 8, 691; DOI: 10.3390/su8070691

Circular bioeconomy. 2016. Business Finland. Available at. http://www.circularbio-ecofin.com/ [Accessed November 30, 2017]

Circular Economy Promotion Law of the People's Republic of China, 2008. Order of the President of the People's Republic of China. World Bank group. Available at. http://ppp.worldbank.org/public-private-partnership/library/china-circular-economy-promotion-law [Accessed January 9, 2018]

Country Overshoot Days, 2017. Global Footprint Network. https://www.overshootday.org/about-earth-overshoot-day/country-overshoot-days/ [Accessed February 16, 2018]

D'Amato, D., Wan, M., Li, N., Rekola, M., Toppinen, A., 2016. Managerial Views of Corporate Impacts and Dependencies on Ecosystem Services: A Case of International and Domestic Forestry Companies in China. Journal of Business Ethics (2016). DOI: 10.1007/s10551-016-3169-8

D'Amato, D., Droste, N., Allen, B., Kettunen, M., Lähtinen, K., Korhonen, J., Leskinen, P., Matthies, B.D., Toppinen, A., 2017. Green, circular, bio economy: A comparative analysis of sustainability avenues. Journal of Cleaner Production 168 (2017), 716–734. DOI: 10.1016/j.jclepro.2017.09.053

Damette, O., Delacote, P., 2011. Unsustainable timber harvesting, deforestation and the role of certification. Ecological Economics, Elsevier, 2011, 70 (6), 1211-1219. DOI: 10.1016/j.ecolecon.2011.01.025

DaSilva, C.M., Trkman, P., 2014. Business Model: What It Is and What It Is Not. Long Range Planning 47 (2014) 379–389. DOI: 10.1016/j.lrp.2013.08.004

Denzin, N.K., Lincoln, Y.S., 2018. The SAGE handbook of qualitative research. SAGE Publications, Inc (2018) 5th edition. 992 p. ISBN: 9781483349800

DiCicco-Bloom, B., Crabtree, B.F., 2006. The qualitative research interview - making sense of qualitative research. Medical Education 2006; 40: 314–321. DOI: 10.1111/j.1365-2929.2006.02418.x

El-Chichakli, B., von Braun, J., Lang, C., 2016. Five cornerstones of a global bioeconomy. Nature Vol 535: 221-223 [Published: 14.7.2016] DOI:10.1038/535221a

Ellen MacArthur Foundation, 2012. Towards the Circular Economy: Economic and Business Rationale for an Accelerated Transition. Available at. https://www.ellenmacarthurfoundation.org/assets/downloads/publications/Ellen-MacArthur-Foundation-Towards-the-Circular-Economy-vol.1.pdf [Accessed November 30, 2017]

EC, 2012. Innovating for Sustainable Growth, A Bioeconomy for Europe. European Commission, 2012. Available at. https://publications.europa.eu/en/publication-detail/-/publication/1f0d8515-8dc0-4435-ba53-9570e47dbd51 [Accessed January 13, 2018]

EC, 2015. Closing the loop - An EU action plan for the Circular Economy, 2015. Communication from the European Parliament, the Council, the European Economic and Social Committee of the Regions. European Commission Brussels, 2.12.2015 COM(2015) 614 final.

EU, 2008. Official Journal of the European Union, L 312, 19.11.2008. Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain directives. Available at. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:312:0003:0030:en:PDF [Accessed December 5, 2017]

EU: Decision 1386, 2013. Official Journal of the European Union, L 354/190, 28.12.2013. Decision 1386/2013/EU of the European Parliament and of the Council of 20 November 2013 on a General Union Environment Action Programme to 2020 'Living well, within the limits of our planet' Available at. http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32013D1386&from=EN [Accessed January 9, 2018]

Folke, C., Biggs, R., Norström, A. V., Reyers, B., Rockström J., 2016. Social-ecological resilience and biosphere-based sustainability science. Ecology and Society 21(3):41. DOI: 10.5751/ES-08748-210341

FSC Principles and Criteria for Forest Stewardship, 2015. Forest Stewardship Council. FSC-STD-01-001 V5-2 EN. Available at. https://ic.fsc.org/en/document-center/id/59 [Accessed May 11, 2018]

Geissdoerfer, M., Savaget, P., Bocken, N.M.P., Hultink, E.J., 2017. The Circular Economy – A new sustainability paradigm? Journal of Cleaner Production 143 (2017), 757–768. DOI: 10.1016/j.jclepro.2016.12.048

Ghisellini, P., Cialani, C., Ulgiati, S., 2016. A review on circular economy: the expected transition to a balanced interplay of environmental and economic systems. Journal of Cleaner Production 114 (2016), 11–32. DOI: 10.1016/j.jclepro.2015.09.007

Global Bioeconomy Summit, 2015. Communiqué, Making Bioeconomy Work for Sustainable Development. Available at. http://gbs2015.com/fileadmin/gbs2015/Downloads/Communique_final_neu.pdf [Accessed January 13, 2018]

Global Footprint Network: Glossary. Global Footprint Network https://www.footprintnetwork.org/resources/glossary/ [Accessed January 3, 2018]

Global material extraction by material category, 1980-2013. Vienna University of Economics and Business, IFEU, Wuppertal Institute, Austrian Ministry for the Environment. Available at. http://www.materialflows.net/materialflowsnet/trends/analyses-1980-2013/global-material-extraction-by-material-category-1980-2013/ [Accessed January 10, 2018]

Gummesson, E., 1991. Qualitative methods in management research. Rev. ed. Newbury Park: Sage. 212 p. ISBN 13: 9780803942042

Haffar, M., Searcy, C., 2018. Target-setting for ecological resilience: Are companies setting environmental sustainability targets in line with planetary thresholds? Bus Strat Env. 2018, 1–14. DOI: 10.1002/bse.2053

Hansen, E., 2016. Responding to the Bioeconomy: Business Model Innovation in the Forest Sector, in: Environmental Impacts of Traditional and Innovative Forest-Based Bioproducts. DOI: 10.1007/978-981-10-0655-5_7

Hetemäki, L., Hanewinkel, M., Muys, B., Ollikainen, M., Palahí, M., Trasobares, A., 2017. Leading the way to A European circular bioeconomy strategy. European Forest Institute. ISBN 978-952-5980-40-0 (online)

Kirchherr, J., Reike, D., Hekkert, M., 2017. Conceptualizing the circular economy: An analysis of 114 definitions. Resources, Conservation & Recycling 127 (2017), 221–232. DOI: 10.1016/j.resconrec.2017.09.005

Kvale, S., Brinkmann, S., 2009. InterViews: learning the craft of qualitative research interviewing. SAGE Publications, Inc (2009) 2nd edition.

Leading the cycle: Finnish road map to a circular economy 2016–2025. 2016. Sitra. Available at. https://media.sitra.fi/2017/02/28142644/Selvityksia121.pdf [Accessed February 16, 2018]

Lieder, M., Rashid, A., 2016. Towards circular economy implementation: a comprehensive review in context of manufacturing industry. Journal of Cleaner Production 115 (2016), 36-51. DOI: 10.1016/j.jclepro.2015.12.042

Liu, Q., Li, H.-M., Zuo, X.-L., Zhang, F.-F., Wang, L., 2008. A survey and analysis on public awareness and performance for promoting circular economy in China: A case study from Tianjin. Journal of Cleaner Production (2009), 17, 265–270. DOI: 10.1016/j.jclepro.2008.06.003

Manninen, K., Koskela, S., Antikainen, R., Bocken, N., Dahlbo, H., Aminoff, A., 2018. Do circular economy business models capture intended environmental value propositions? Journal of Cleaner Production 171 (2018), 413-422. DOI: 10.1016/j.jclepro.2017.10.003

Marshall, B., Cardon, P., Poddar, A., Fontenot, R. (2013). Does sample size matter in qualitative research? A review of qualitative interviews in IS research. Journal of computer information system, 54(1), 11–22. DOI: 10.1080/08874417.2013.11645667

Mattila, T.J., Judl, J., Macombe, C., Leskinen, P., 2018. Evaluating social sustainability of bioeconomy value chains through integrated use of local and global methods. Biomass and Bioenergy 109 (2018), 276–283. DOI: 10.1016/j.biombioe.2017.12.019

Maxwell, J.A., 2009. Designing a Qualitative Study In: The SAGE Handbook of Applied Social Research Methods. SAGE Publications, Inc (2009) 2nd Edition.

McDonough, W., Braungart, M., 2002. Cradle to Cradle: Remaking the Way We Make Things, North Point Press, New York, NY (2002).

Meyer, R., 2017. Bioeconomy Strategies: Contexts, Visions, Guiding Implementation Principles and Resulting Debates. Sustainability 2017, 9, 1031, 1-32. DOI: 10.3390/su9061031

Millennium Ecosystem Assessment, 2005. Ecosystems and Human Well-being: Synthesis. Island Press, Washington, DC.

Murray, A., Skene, K., Haynes, K., 2016. The Circular Economy: An interdisciplinary exploration of the concept and application in a global context. Journal of Business Ethics 2015. DOI: 10.1007/s10551-015-2693-2

OECD, 2009. The Bioeconomy to 2030, Designing a policy agenda. Available at. http://www.oecd.org/futures/bioeconomy/2030 [Accessed January 13, 2018]

Oghazi, P., Mostaghel, R., 2018. Circular Business Model Challenges and Lessons Learned—An Industrial Perspective. Sustainability 10, 1–19. DOI: 10.3390/su10030739

Ormazabal, M., Prieto-Sandoval, V., Puga-Leal, R., Jaca, C., 2018. Circular Economy in Spanish SMEs: Challenges and opportunities. Journal of Cleaner Production 185 (2018) 157-167. DOI: 10.1016/j.jclepro.2018.03.031

Osterwalder, A., Pigneur, Y., Tucci, C.L., 2005. Clarifying business models: origins, present, and future of the concept. Communications of the Association for Information Systems 16 (1), 1–25. Available at: http://aisel.aisnet.org/cais/vol16/iss1/1 [Accessed November 15, 2017]

Past Earth overshoot days 1969-2017. Global Footprint Network. https://www.overshootday.org/newsroom/past-earth-overshoot-days/ [Accessed January 10, 2018]

PEFC-metsäsertifioinnin kriteerit, 2014. PEFC Suomi. PEFC FI 1002:2014. http://pefc.fi/wp-content/uploads/2016/09/PEFC_FI_1002_2014_Metsaesertifoinnin_kriteerit_20141027.pdf [Accessed May 11, 2018]

Pelli, P., Haapala, A., Pykäläinen, J., 2017. Services in the forest-based bioeconomy – analysis of European strategies. Scand. J. For. Res. 1–9. DOI: 10.1080/02827581.2017.1288826

Pfau, S.F. Hagens, J.E. Dankbaar, B. Smits, A.J.M. 2014. Visions of Sustainability in Bioeconomy Research. Sustainability 2014, 6, 1222–1249.

Priefer, C., Jörissen, J., Frör, O., 2017. Pathways to Shape the Bioeconomy. Resources 2017, 6, 10, 1-23. DOI: 10.3390/resources6010010

Recycled fibre is a valuable raw material. Finnish Forest Industries. 2017. available at. https://www.forestindustries.fi/in-focus/environment-and-sustainibility/circular-economy/recycled-fibre-is-a-valuable-raw-material/ [Accessed May 8, 2018]

Reim, W., Sjödin, D., Parida, V., Rova, U., Christakopoulos, P., 2017. Bio-economy based business models for the forest sector – A systematic literature review. In: Proceedings of the 8 The International Scientific Conference Rural Development. DOI: 10.15544/RD.2017.109

Richardson, J., 2008. The business model: an integrative framework for strategy execution. Strateg. Change 17 (5-6), 133–144. DOI: 10.1002/jsc.821

Rockström, J., Steffen, W., Noone, K., Persson, Å., Chapin, F.S., Lambin, E.F., Lenton, T.M., Scheffer, M., Folke, C., Schellnhuber, H.J., Nykvist, B., de Wit, C.A., Hughes, T., van der Leeuw, S., Rodhe, H., Sörlin, S., Snyder, P.K., Costanza, R., Svedin, U., Falkenmark, M., Karlberg, L., Corell, R.W., Fabry, V.J., Hansen, J., Walker, B., Liverman, D., Richardson, K., Crutzen, P., Foley, J.A., 2009. A safe operating space for humanity. Nature. Vol 461, 24 September 2009 472-475. DOI: 10.1038/461472a

Schaefer, F., Luksch, U., Steinbach, N., Cabeça, J., Hanauer, J., 2006. Ecological Footprint and Biocapacity: The world's ability to regenerate resources and absorb waste in a limited time period. European Commission's working papers and studies. Available at. http://ec.europa.eu/eurostat/documents/3888793/5835641/KS-AU-06-001-EN.PDF [Accessed January 3, 2018]

Steffen, W., Richardson, K., Rockström, J., Cornell, S.E., Fetzer, I., Bennett, E.M., Biggs, R., Carpenter, S.R., de Vries, W., de Wit, C.A., Folke, C., Gerten, D., Heinke, J., Mace, G.M., Persson, L.M., Ramanathan, V., Reyers, B., Sörlin, S., 2015. Planetary boundaries: Guiding human development on a changing planet. Science Vol. 347, Issue 6223, 1259855. DOI: 10.1126/science.1259855.

Teece, D.J., 2010. Business models, business strategy and innovation. Long Range Planning Volume 43 (2–3), 172–194. DOI: 10.1016/j.lrp.2009.07.003

The Finnish bioeconomy strategy. 2014. Finnish Ministry of Employment and the Economy. Available at. http://biotalous.fi/wp-content/uploads/2014/08/The_Finnish_Bioeconomy_Strategy_110620141.pdf [Accessed February 16, 2018]

Timmermans, S., Tavory, I., 2012. Theory Construction in Qualitative Research: From Grounded Theory to Abductive Analysis. Sociological Theory 30(3) 167–186. DOI: 10.1177/0735275112457914

UNECE/FAO Forest Products Annual Market Review, 2016-2017. Available at. https://www.unece.org/fileadmin/DAM/timber/publications/FPAMR2017.pdf [Accessed May 11, 2018]

United Nations, 2015a. Transforming our world: the 2030 Agenda for Sustainable Development. Resolution adopted by the General Assembly on 25 September 2015. Seventieth session Agenda items 15 and 116. 1-35. Available at. http://www.un.org/ga/search/view_doc.asp?symbol=A/RES/70/1&Lang=E [Accessed January 3, 2018]

United Nations, 2015b. Paris Agreement. Available at. http://unfccc.int/files/essential_background/convention/application/pdf/english_paris_agreement.pdf [Accessed January 12, 2018]

United Nations, 2017. World Population Prospects: The 2017 Revision Key Findings and Advance Tables. Available at. https://esa.un.org/unpd/wpp/Publications/Files/WPP2017_KeyFindings.pdf [Accessed January 3, 2018]

Van Buren N., 2016. Towards a circular economy: the role of Dutch logistics industries and governments. Sustainability 2016, 8, 647. DOI: 10.3390/su8070647

WCED, 1987. Report of the World Commission on Environment and Development: Our Common Future. Available at. http://www.un-documents.net/our-common-future.pdf. [Accessed November 30, 2017]

Whiteman, G., Walker, B., Perego, P., 2013. Planetary Boundaries: Ecological Foundations for Corporate Sustainability. Journal of Management Studies 50:2 March 2013 307-336. DOI: 10.1111/j.1467-6486.2012.01073.x

Wijkman A., Skånberg K., 2015. The Circular Economy and Benefits for Society: Jobs and Climate Clear Winners in an Economy Based on Renewable Energy and Resource Efficiency. A study report at the request of the Club of Rome. Available at: https://www.clubofrome.org/wp-content/uploads/2016/03/The-Circular-Economy-and-Benefits-for-Society.pdf [Accessed November 30, 2017]

Winn, M.I., Pogutz, S., 2013. Business, Ecosystems, and Biodiversity. Volume: 26 issue: 2, page(s): 203-229 Article first published online: May 26, 2013; Issue published: June 1, 2013. DOI: 10.1177/1086026613490173

Wirtz, B.W., Pistoia, A., Ullrich, S., Göttel, V., 2016. Business Models: Origin, Development and Future Research Perspectives. Long Range Planning 49 (2016) 36–54.

8. Appendix

Appendix 1.

Questionnaire

Questionnaire starts

Identifying questions:

1. When was the company established?
2. What were the initial motivations to start the company?
3. What is the size of the company? Employees? Turnover?
4. What is your role in the company?
5. What is your familiarity with the circular-bioeconomy?

Open questions:

6. What kind of products / services does your company provide?
7. What are the innovative / revolutionary aspects of your company's products / services?
8. What are the competing or alternative products / services?
9. What does your company do differently in manufacturing processes and/or other operations?
10. How do your key partners support/enable your value creation? E.g. shareholders, employees, suppliers, contractors, customers, local communities and other stakeholders.
11. Please describe in what way your business model could lead to cost reduction / profit increase compared to dominant business logic (directly or indirectly)?
12. How does your company provide positive contribution to environmental and social sustainability?
13. Where will your company be in 5 to 10 years and what business opportunities and challenges do you foresee to arise from the circular bioeconomy?
14. Any other comments / ideas / opinions?

Questionnaire ends

Kysymykset

Kysely alkaa

Yksilöivät

1. Milloin yritys on perustettu?
2. Mitkä olivat yrityksen perustamisen perimmäiset syyt?
3. Kuinka suuri yritys on? Henkilöstöltään? Liikevaihdoltaan?
4. Mitkä ovat työtehtävänne yrityksessä?
5. Kuinka hyvin tunnette käsitteen kiertobiotalous?

Avoimet

6. Minkälaisia tuotteita / palveluita yrityksenne tarjoaa?
7. Mitkä ovat yrityksenne tuotteiden / palveluiden innovatiiviset / mullistavat ominaisuudet?
8. Mitkä ovat kilpailevia tai vaihtoehtoisia tuotteita / palveluita?
9. Mitä yrityksenne tekee eri tavalla valmistusprosessissa ja / tai muissa toiminnoissa?
10. Kuinka keskeiset kumppaninne tukevat / mahdollistavat arvon muodostamisessa? Esim. osakkeenomistajat, työntekijät, tavarantoimittajat, urakoitsijat, asiakkaat, paikalliset yhteisöt tai muut sidosryhmät
11. Kuvailkaa, millä tavoin liiketoimintamallinne voi johtaa kustannusten laskuun / tulojen kasvuun verrattuna hallitsevaan liiketoimintalogiikkaan (suorasti tai epäsuorasti)?
12. Kuinka yrityksenne turvaa myönteisen vaikutuksen ympäristön kestävyyteen ja sosiaaliseen kestävyyteen?
13. Missä näette yrityksenne olevan 5 – 10 vuoden päästä, ja mitä liiketoimintamahdollisuuksia ja –haasteita näette kiertobiotaloudessa tulevaisuudessa?
14. Muita kommentteja / ideoita /mielipiteitä?

Kysely loppuu

Appendix 2.

Codes

!Feeling to have little contribution
CHALLENGE
challenge: Co-operation/dialogue
challenge: Export promotion
challenge: Financial reasons
challenge: Legislation
challenge: Market penetration
challenge: Recycling system
challenge: Technology
COMMUNICATION
communication: Finnish-based
communication: Lifecycle impacts
communication: More sustainable alternative
COST STRUCTURE & REVENUE STREAMS
cost/revenues: Cheaper than alternative
cost/revenues: Competition in price
cost/revenues: Higher price from branding
cost/revenues: Higher price from product design
cost/revenues: Incomes from export
cost/revenues: Incomes from fast service
cost/revenues: Incomes from new market areas
cost/revenues: Incomes from selling the product idea
cost/revenues: Incomes from unique qualities
cost/revenues: Incomes from wide product selection
cost/revenues: Lower costs from less raw materials
cost/revenues: Lower fixed costs from partnering
cost/revenues: No need for big investments
cost/revenues: Raw material costs dropped by big volume
cost/revenues: Reducing transport costs
GROWTH STRATEGY
growth strategy: Creating new value chains
growth strategy: Export sales
growth strategy: International markets
growth strategy: Licensing
MOTIVATION
motivation: Commercializing scientific finding
motivation: Commercializing technology based innovation
motivation: Commercializing wood-composite based product
motivation: Market-driven demand
OPPORTUNITY
opportunity: Demand from industry for more sustainable alternatives
opportunity: Growing demand for new solutions
PARTNERSHIP
partnership: Co-operation with research institutes/universities
partnership: Co-operation/partnering with international industrial companies
partnership: Code of conduct procedure in partner selection

partnership: Partners enabling more dynamic organization
partnership: Partners providing business services
partnership: Shared infrastructural services with partners
PROCUREMENT
procurement: Using existing raw material supply
procurement: Using freelancers in raw material supply
PRODUCT FEATURES
product features: Designed into recycling system
product features: Designed to be biodegradable
product features: Designed to be more durable
product features: Designed to be reprocessed with existing production infrastructure
product features: Designed to be scaled up
product features: Designer product
product features: Different service attitude
PRODUCT/SERVICE
product/service: Forest-based health product
product/service: Forest-based material for packaging solutions
product/service: Forest-based textile fiber
product/service: Industrial enzymes and supporting services for bio-industry
product/service: R&D concepts
product/service: Wood composite product family
PRODUCTION
production: Co-owned production with partners
production: Outsourced production capacity
production: Own production capacity
production: Using strategical partners in production
R&D
r&d: Developing new value chains with the partners
r&d: Partners providing research
RESOURCES
resources: Using innovative raw material combination
resources: Using moderate amount of raw material
resources: Using recycled materials as raw material (potential)
resources: Using renewable resources
resources: Using third party certificated resources
resources: Using uncommon raw material
resources: Using waste as raw material
TECHNOLOGY
technology: Generating less undesirable outputs from production
technology: Less inputs in production
technology: New production technology
technology: Safer and/or non-chemical production process
VALUE CAPTURE FOR KEY ACTORS
value for key actors: Competitive advantage for partners
value for key actors: Creating jobs
value for key actors: Dropping user's expenses
value for key actors: Growing incomes for industrial partners
value for key actors: Guiding customers' buying behavior
value for key actors: Improving users' quality of life
value for key actors: Preserving nature in raw material supply

value for key actors: Reducing environmental stress in production
value for key actors: Reducing partners' development costs and risk
value for key actors: Reducing plastics ending to environment
value for key actors: Reducing social inequity
value for key actors: Reducing transport emissions
value for key actors: Reducing waste of others
value for key actors: Securing food system
VALUE PROPOSITION FOR CUSTOMER, ENVIRONMENT, SOCIETY
value proposition for: Offering better functionality from natural alternative
value proposition for: Offering environmentally and/or socially better alternative
value proposition for: Offering natural alternative for healthcare
value proposition for: Offering R&D concepts for others to commercialize
value proposition for: Offering same functionality with improved qualities
value proposition for: Offering technical solutions faster to (bio-)industry-scale
value proposition for: Replacing non-renewable with bio-based renewable
value proposition for: Turning waste into higher value product